

The First Book of the Earth

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The First Book of the Earth





Drawing by Norman Price

FIG. 1. What do you think Tom is hearing about the world?

CHAPTER I

Seeing the World

Tom was sitting on the shore.

He was looking at the big city.

This is what he said :

I see water on every side.

I see ships coming into the harbor,

ships from near,

ships from far,

I see them loading and unloading, with people
everywhere.

Down below I see streets and the roofs of
buildings.

Everywhere are people, — moving, moving,
moving, —

in automobiles,

in trains,

on foot.

I see very little grass and few trees.

Nancy was up very high.
She could look down on a farm.
This is what Nancy said:

I see farmers at work in the fields.
I see the horses pulling and pulling.
I see a winding river flowing slowly
through the fields.

Some other children were looking at a city.
This is what they said:

I see a great ocean steamship coming from far
away.
I see the harbor, where ships are
sheltered from the storm.
I see the sailors, carrying loads of
tea and silk and rice.
I see a city built up and down hill.
I see people everywhere.

All of these children were looking at the world.
One saw the city and the harbor. One saw the farms
and the fields. Others saw the ocean and the ships.
Each one saw the world in a different way.



FIG. 2. What does Nancy see as she looks at the world?

Drawing by Norman Price

Do you see the world in the same way that those children did? Perhaps not. There are many, many ways of seeing the world.

Here is another way. It is the way Mr. Rands, the poet, saw the world.

THE WONDERFUL WORLD

Great, wide, beautiful, wonderful World,
With the wonderful water round you curled,
And the wonderful grass upon your breast,—
World, you are beautifully dressed.


The wonderful air is over me,
And the wonderful wind is shaking the tree,
It walks on the water, and whirls the mills,
And talks to itself on the top of the hills.

You friendly Earth! How far do you go,
With the wheat fields that nod and the rivers that flow,
With cities and gardens, and cliffs, and isles
And people upon you for thousands of miles?

The children saw the world in one way. The poet saw it in another. Did they see all of it? No, indeed. They saw only small bits of it. Even if they had gone to the highest places, they could have seen only a small part of the world.

The poet asked the world a question. He said, "You friendly Earth! How far do you go?" Have you wondered how far the world goes? Most people have. Some of them have traveled and traveled, trying to see the whole world.

But not until the airplane was invented could anyone see much of the world at one time. Now aviators can fly toward the sky. They can look back on the earth. They see more of the world than has ever been seen before. The next pages show how one aviator saw the world.



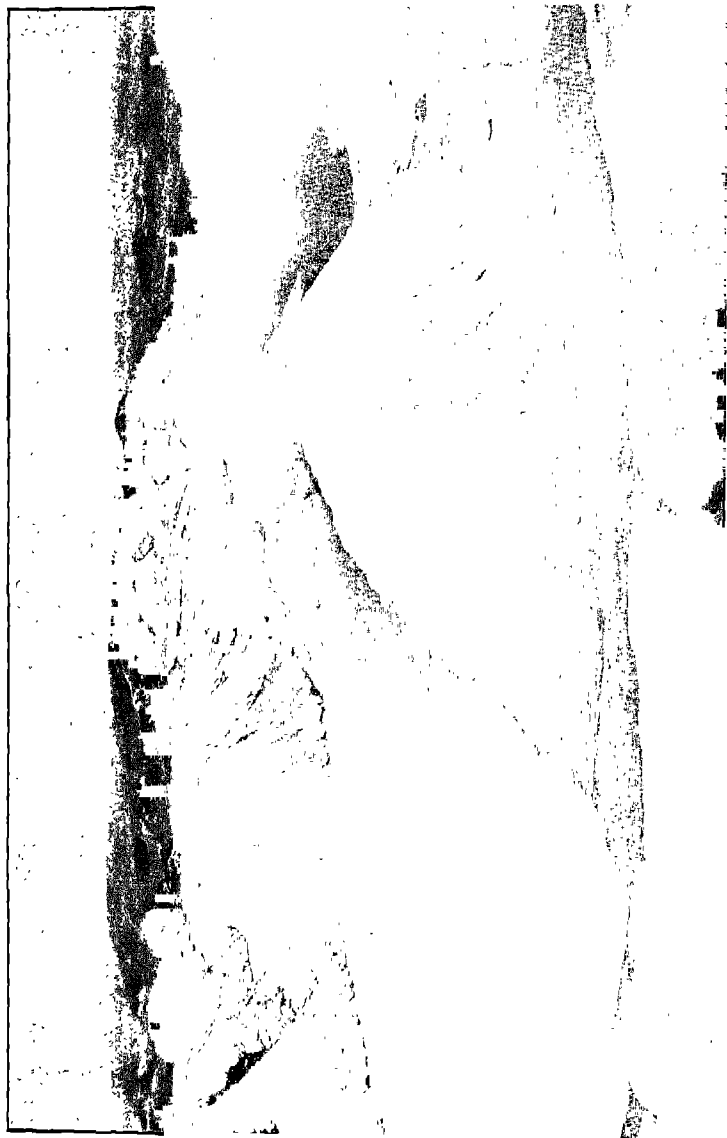


FIG. 3. Looking down on a rocky coast in the far north of North America, the aviator sees a wild country. He sees mountains on which there is no soil, no trees, no roads



Pittsburgh Aerial Survey

FIG. 4. Above farming lands in western Pennsylvania, in the United States. The fields are carefully planted. The green hills are covered with trees. Smooth roads wind through the country



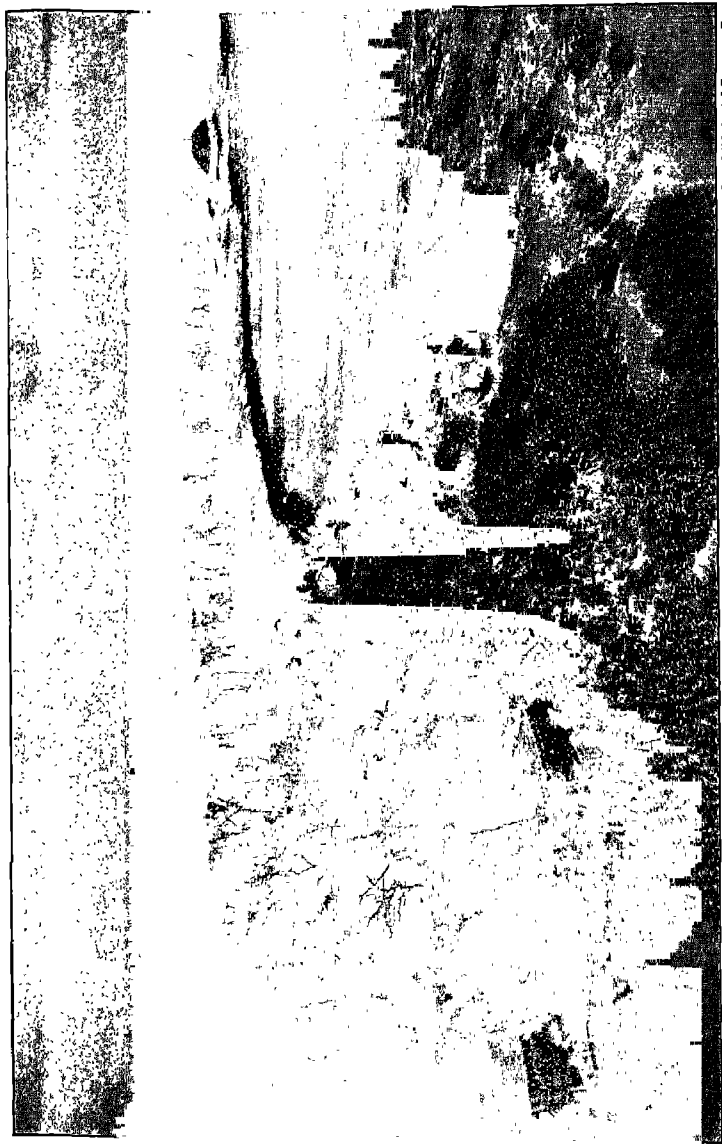
Ewing Galloway

FIG. 5. The aviator sees an old town in western China. There are no farms, no fields, and few trees. But, as you can see, people live there. There are many houses built close together. Does this look like a picture of our country?



Wide World

FIG. 6. The birdman is looking down on a great city in South America. The tall buildings, good streets, automobiles, and street cars make us think of the cities of our own country. Do you think many people live here?



Farchild Aerial Surveys, Inc.

FIG. 7. The airplane roars over Indian homes in Mexico. Rough houses are built among the bushes and on the sandy ground at the edge of the sea. There are no smooth fields or roads



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FIG. 8. Looking down on a town in California, in the United States. High mountains, neat houses in the valley, smooth roads, and flat places where men have planted rows of trees

CHAPTER II

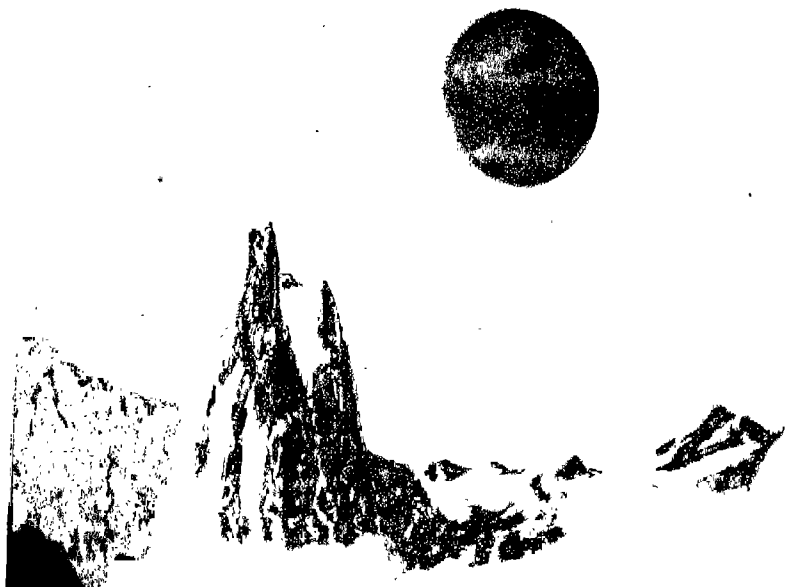
Our Earth Is a Great Round Ball

TODAY ALMOST everyone believes that the earth is round like a great ball. Really, of course, it is not perfectly round. At the north pole and south pole it is a little flat. But because it is nearly round we call the earth round.

People have not always known that the earth is round. For many years, perhaps thousands of years, they wondered about its shape. "Is the earth like an apple? Is it like a pear? Or is it like a box?" they asked.

They went to the tops of hills and looked far and wide to find an answer. They climbed to the highest places and looked as far as they could see. But they could really see only a very little part of the earth. And because they could see so little, they had some strange ideas about it.

Long ago most people thought the earth was flat. They thought that if you went far enough



The Earth as Seen from the Hills of the Moon
From a Painting by Howard Russell Butler, N. A., in the American Museum of
Natural History, New York

you would come to the edge and reach the sky. That is what one small boy thought. Here is his story:

A Boy's Strange Idea

Not so long ago there lived a small boy. Like most small boys he looked at the sky and the sun and the stars. The more he looked, the more he wondered about them.

Many questions came to his mind. Where does the sky begin? Where does the earth end? Where does the sun go at night? He thought and thought, and wondered and wondered.

Almost every morning he saw the sun come up from behind one hill. Almost every evening he saw it go down behind another. Surely, he thought to himself, the earth is flat, and the sky is a big bowl turned upside down. The bowl is resting on the edge of the flat earth. If I walk to the edge, I shall have to bend down so as not to bump my head against the sky.

One day he could think about it no longer. He must start out to find the place where the sky rested on the edge of the earth. So he put some lunch into a basket and set out on his way.

First he walked quickly, hoping to reach the place and to touch the sky with his hand. But before long he became tired, and his legs began to ache.

"I must be getting there soon," he thought.

On and on he went. Then he remembered his lunch and sat down on a stone to eat.

"How strange it is," said the boy to himself. "The sky seems to be just as far away as ever."

After eating his lunch he rested for a long while. Then he started out again. He walked and walked.

At last he could go no farther.

"The edge of the earth must be very far away," he said. "I wonder if I shall ever reach it."

He became a little afraid and decided he must go home. Tired and hungry, he gave up hunting for the edge and went back the road he had come.

"My legs are not long enough and strong enough to carry me so far," said the boy. "Perhaps when I grow up I shall be able to reach the edge of the earth and touch the sky."¹

¹ Suggested by Jean-Henri Fabre, *This Earth of Ours*, p. 3. D. Appleton-Century Co., New York, 1923.

Do you see that the boy still thought that the earth was flat and that the sky rested on it like a bowl? Do you think of the earth the way he did?

Perhaps not; for you know that the earth is round, not flat. You know, too, that, if you went on and on and on you might go around the world and come back to the place where you began.

**How Do We Know that the Earth Is a
Round Ball?**

People have learned in different ways that the earth is round.

One day some men were sitting on the shore, looking out to sea. From far away came a sailboat. As it came toward them they saw the top of the long pole that holds the sail. Then they saw the sail. At last the main part of the boat was seen.

"That is strange," said one of the men. "If the earth were flat, we should see the main part of the boat and the sail at the same time. The earth must be round."

That was one of the first ways in which people proved that the earth is round — by seeing things from far away.

You can prove this yourself. Make a tiny ship of paper. Move it over the globe in the way a ship would sail toward you as the children are doing in figure 9. What do you see first? What do you see next? What is the last thing you see? Does that help you to prove that the earth is round?

Sailing around the World

It happened, too, that a few people who traveled on the water began to think that the earth is round. They thought that if you sailed and sailed and sailed you would come back to the place from which you had started.

The first man to sail around the world was Ferdinand Magellan. He lived about 400 years ago in Spain.

Magellan was a great traveler on land and sea. After sailing far and wide he decided to find a way to go around the world. But he needed money to buy ships and to buy food for his men.

First he went to the king of Spain. He told the king about his plans and asked if he would help. The king liked the plans very much and said that he would be glad to help Magellan.



Anne Shriver

FIG. 9. These children proved for themselves that the earth is round

So, in August of the year 1519, Magellan set out with five ships and many men. They sailed and sailed and sailed. Across the seas they went, not knowing when they would come back to their own country.

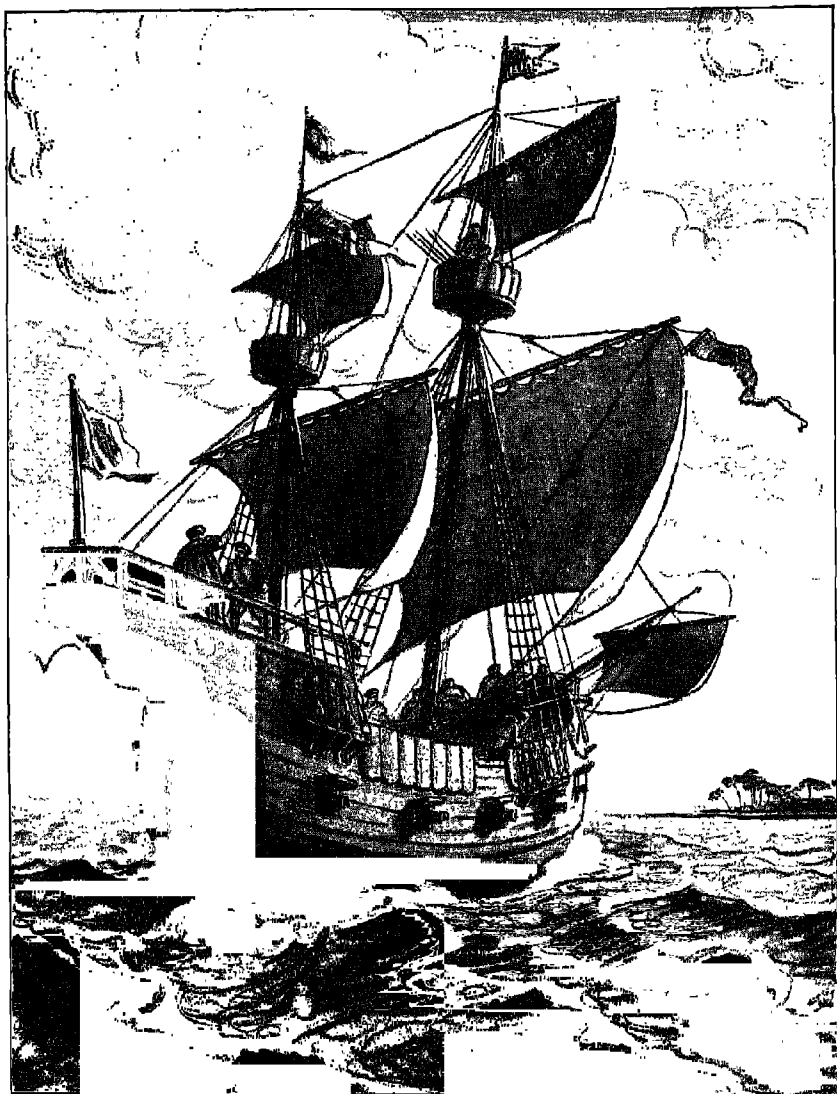
After several months the fresh food was gone. There was little water, too. The men became sick, and many of them died. But on went the rest, sailing and sailing and sailing.

Almost two years later they came to some islands. Here they stopped to get fresh food and water. But while they were there Magellan was killed in a fight with the people of the island. He did not live to tell about his journey.

But his men went on, and after many troubles they reached Spain again with one ship left. Only a very few men came back in that first ship to go around the world. It had taken more than three years to make the trip.

Although Magellan did not finish his journey, he proved that you could sail around the world. He proved that the earth is round.

Since Magellan's day other people have gone around the world. They have started from a city,



Drawing by Harold Sichel

FIG. 10. Magellan sailed across the sea in this kind of boat

such as New York, and traveled from place to place until they came back to the city from which they started. Every year thousands of people go by steamship, by train, by automobile, or by airplane. There are even steamships which take people around the world, stopping at many places on the way.

In this way you see that there are many ways of knowing that the earth is round. Later you will find that there are still others.

CHAPTER III

The Earth Is Just a Speck in Space

THE CHILDREN were all looking at the globe which rested on the table in one corner of the room. Nancy had a question to ask. She was thinking of the earth as a great round ball, and she wondered where it could be.

"I don't understand," she said. "I can see that the earth is round. I can see that it is like a ball. But where is it?"

"That is just what I was thinking," said Dick. "What holds it up? Is the earth resting on a stand, like our globe?"

All the children laughed. Then several talked at once.

"I used to think," said Mary, "that it was a great ball held up in the sky by a giant string."

"Oh, I dreamed once that the earth was a great flat thing held up by a very large man — a giant," said Tom.



FIG. 11. The flat earth floating on a sea

Miss Brown smiled and went to a shelf of books in the corner of the room.

Taking a book, she opened it to a page beginning with some stories about the earth.

"That is exactly what many people who lived long ago believed," she said.

What People Long Ago Believed

Hundreds of years ago, if not thousands of years ago, people thought that the earth was flat. It was flat like a pancake, and it floated about in a great big sea. In the morning the sun came out of the sea and gave the earth light. At night it sank into the sea again, and darkness came. Figure 11 shows how these people thought about the earth.

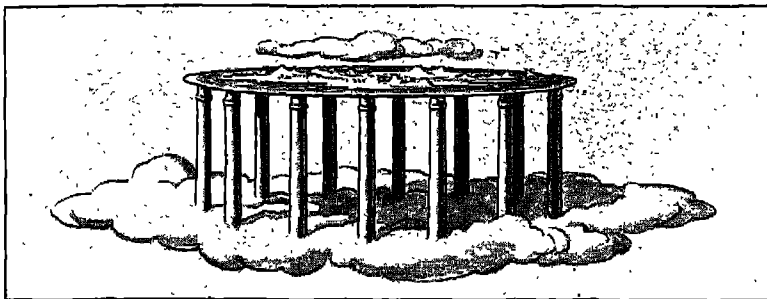


FIG. 12. The flat earth held up by posts

But all people of long ago did not have that idea of the earth. Some of them did not understand the idea of the earth's floating in the sea. They said: "A tree has roots to hold it in the ground. A lily floating in the water has roots. There must be something to hold the earth in place." So they believed that the earth was flat, but that it had roots which were down in the deep waters of the sea.

Many people, however, did not like the idea that the earth had roots in the sea and that it moved about, like a plant, in the water. They thought it ought to stand on something.

Figure 12 is a picture of their idea. You can see that they thought there were twelve posts holding up the flat earth.

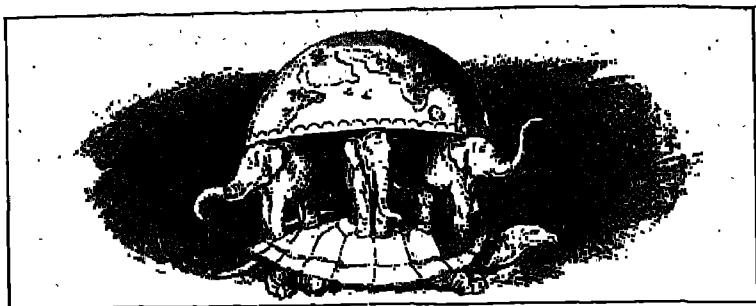


FIG. 13. The earth held up by elephants

Hundreds of years later people began to believe that animals held up the earth. The people of India had that idea. Figure 13 shows you what they thought. The four elephants are standing on the back of a turtle and are holding the earth on their backs. You can see that these people had begun to think that the earth is half a globe and not flat.

Many other strange ideas about the earth have been in the minds of people. In places where there were no elephants or turtles they thought that giant fish were holding up the earth. Others thought it was a giant cow.

The Greeks who lived in Greece more than 2000 years ago believed something different. They thought that a man called Atlas took care of the

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posts on which the sky rested. Many years later someone made a statue of Atlas and showed him holding the round earth on his shoulders.

So you can see that before men knew where the earth is, they thought and thought and wondered and wondered. They were always asking, just as Nancy did: "Where is the earth? On what does it rest?"

"Yes," said Nancy. "Where is the earth really?"

The Earth Really Moves in Space

Today we know that the earth is not held up by tall posts or by elephants and turtles. We know that it is shaped like a great round ball and that it is spinning and moving in space.

What is space? Is it the air above the earth? How far does it go? How does the earth spin in space?

Let us imagine we are on a magic cloud on which we can ride wherever we wish. We are leaving the earth and going out into space.

Away we go! On and on we ride! Faster and faster we go, out and out and out into the great space! Now we are far away from the earth. We look out at the stars. They seem like points of light.



Drawing by Harold Sichel

FIG. 14. Seeing the universe from a magic cloud

The Earth Is Just a Speck in Space 29

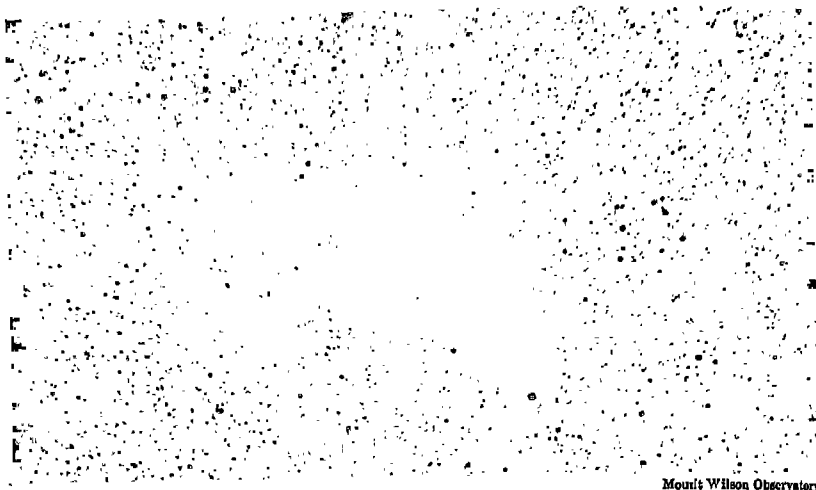
We ride through miles and miles of space. We stop for a moment and look back on the earth. What does the earth look like now? It seems to be a speck of light. Our earth looks just like a tiny moon in the big, big space around us.

Let us go on through many more millions of miles of space. The stars now seem like specks of light rushing past us very, very fast. They go about a thousand times as fast as the fastest train. Strange as it may seem, each one travels its own way, rushing on and on.

Are we safe in this great space, watching the stars and the earth as they move and whirl? Yes, it is quite safe, for one star may move for millions and millions of years without bumping into another star.

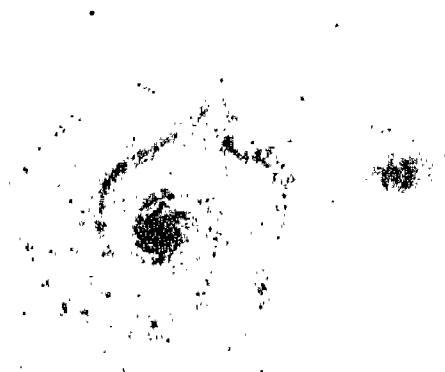
What millions and millions of stars there are! It looks as if someone had taken a big bag of sand and had poured it out all over space. This must be the Milky Way! The whole space seems filled with stars, and each star is a tiny speck of light.

In some places the specks are close together. In other places the specks are far away from one another, with millions and millions of miles between them.



Mount Wilson Observatory

FIG. 15. The Milky Way has millions and millions of stars. Our sun is one of them. Do you think you could find it?



Mount Wilson Observatory

FIG. 16. A nebula spinning and moving through space

The Earth Is Just a Speck in Space 31

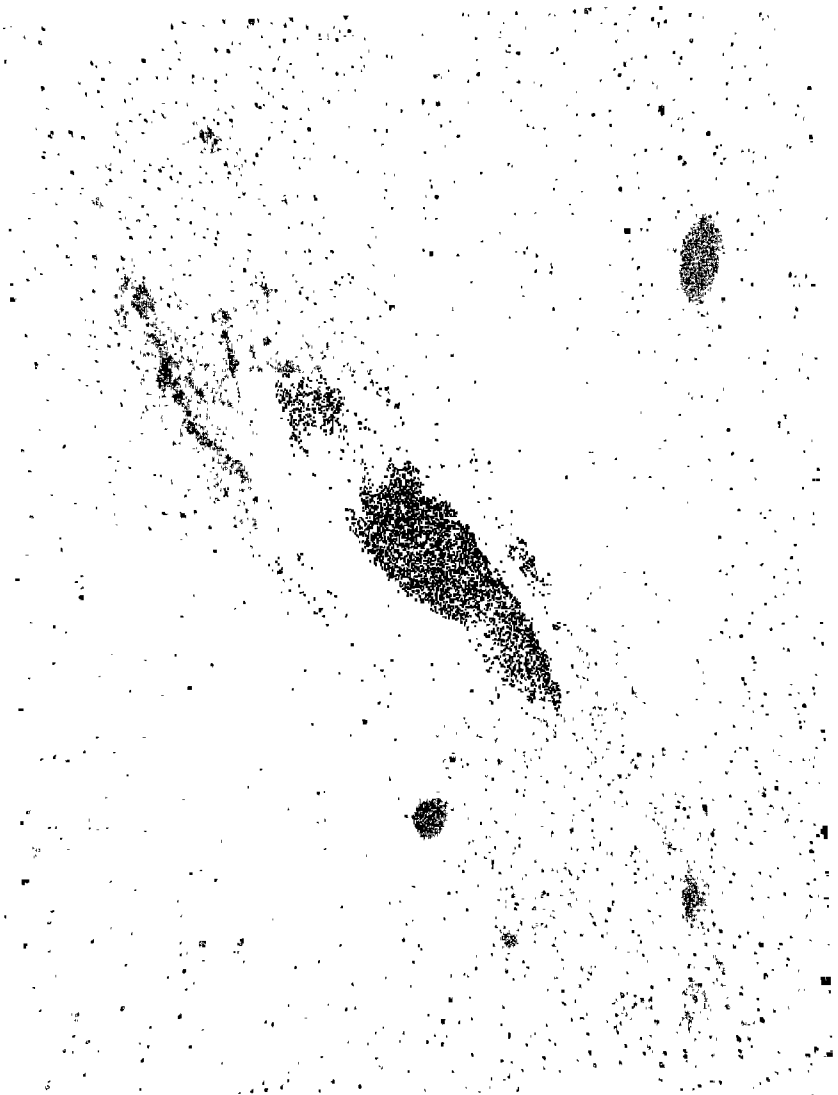
Let us go near one of the places where the stars are close together. Here are thousands and thousands of stars whirling together through space.

We go on and on. Scattered everywhere are other great clouds of stars. All of them have millions and millions of stars. Around many of the stars are large clouds of gas. This covers the stars and hides some of the light from us.

Each cloud of stars and dust is called a "nebula." More than one nebula is called "nebulae." These huge nebulae, or clouds of stars, are bigger than anything we have ever seen. They are many, many times as big as our earth today. And they are whirling, always whirling, through space, faster than anything we have ever seen.

Can you imagine that there are so many of these nebulae scattered over space? Can you imagine too that a single nebula has millions and millions of suns? A single nebula! Millions of stars, and each one huge and hot and whirling. And each nebula is miles and miles away from the others.

Some of the nebulae are different from others. The clouds of gas spin and spin until they become round. Others spin faster and faster. The ball



Yerkes Observatory

FIG. 17. Another great nebula in the universe

shape becomes flatter and thinner. In figures 16 and 17 you can see the pictures of different nebulae.

We try to see our sun. It is a little speck of light in the Milky Way. It is a star, just like all the other stars in space.

We start back to the earth. On our way we see other specks that look like our earth. Some of them are larger than our earth; others are smaller. They seem to be traveling together. We look more closely and see that they are moving around our sun. What are they? We must learn more about them when we get back to earth.

Now we touch the earth. We are at home again. Our houses seem quite big. Our hills seem quite high. Even our mothers and fathers seem quite tall. But we have just learned that our whole earth is just a speck, like a speck of sand, in the great, great space.

Our sun, which is really a star, is also one of those specks of sand. There are millions and millions and millions of sun-stars or star-suns in a single nebula. There are millions and millions and millions of nebulae. All of them are spinning and moving through space. *That is the universe.*

CHAPTER IV

How Our Earth Was Born

Do you know that there was a time when there was no earth? There were no flowers and trees, no lakes and rivers, no rocks and hills, no animals, and no people.

That was long, long ago; nobody knows how long ago. It was perhaps more years than anybody has ever counted.

What happened? How did our earth, which was not here in that time so long ago, become the great round ball that it is?

That is a question which even today we cannot answer exactly. The people who study the universe carefully have learned much about the sun and the moon and the stars. But they do not know all about them.

Let us see just what they do know. Let us see what they think about how the earth came to be.

How Was Our Earth Born?

Nobody really knows how our earth was born, but people who study it have thought of several ways that it might have happened. The picture of figure 18 shows us one of the ways.

More than a hundred years ago there lived in France a man by the name of Laplace. Laplace studied about the earth. He studied the sun and the moon and other stars, too. He had an idea about how the earth came to be.

Laplace thought that the whirling masses of gas, like the sun, went so fast that parts of them flew off into space. One of these parts cooled and became the earth. For a long time people thought that Laplace's idea was the only one which told the story.

A few years ago, however, two men had another idea of how the earth was born. They thought that masses of gas could not fly off into space in this way. Many people think that the idea that these two men had is a better one than Laplace's.

Here is the way they tell the story:

Our sun was a mass of gases spinning and whirl-



Drawing by Harold Siegel

FIG. 18. How Laplace thought the earth was born

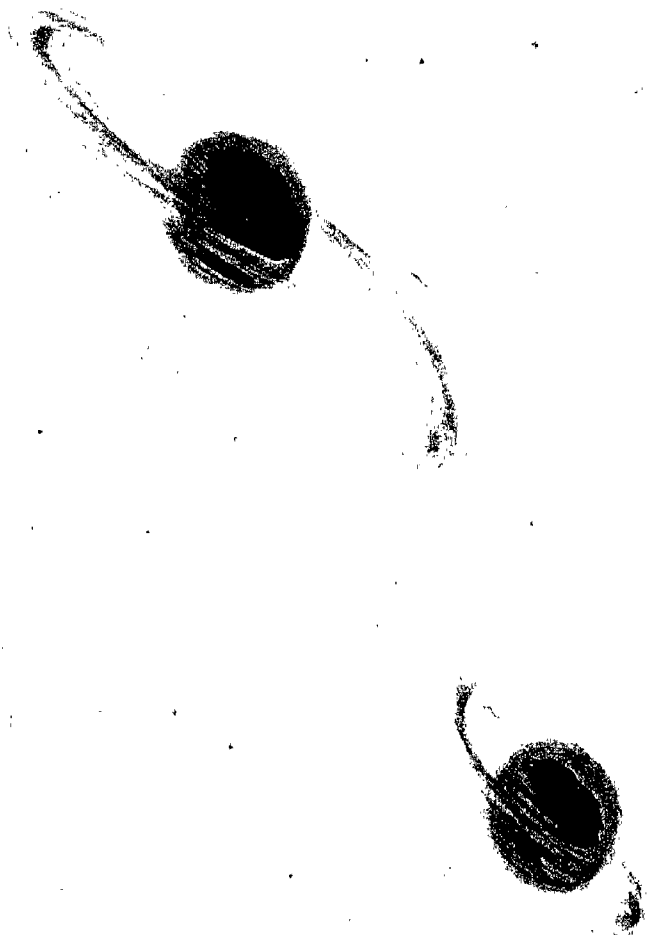


FIG. 19. Another sun pulling masses of gas from our sun

Drawing by Harold Stebbins

ing in the universe. This went on for no one knows how many millions of years.

Then something strange happened. Another great sun, going along on its path, passed near our sun.

This was perhaps one of the very few times that such a thing had happened. The stranger sun was much larger than our sun. It, too, was spinning and moving with great force, and had a strong pull on everything near it.

Millions of years passed. During all this time the stranger sun was moving ever closer and closer to our sun. Harder and harder it pulled on our sun, pulling some of the hot gases from it. It was as though a giant were stirring a huge furnace full of flame and smoke.

Closer and closer to our sun came the stranger sun, pulling with all its force. Higher and higher, bigger and bigger, rose the dust and gases. Our sun pulled too, but it was not so strong as the other sun.

At last, as the picture of figure 19 shows, huge clouds of gas and dust were pulled away from our sun. Out into space they went. Some of them

went far, far away. Others stayed nearer to the sun. Some were large masses, and others were smaller ones.

Whirling and spinning, each of these went on its own way, moving away from our sun until it could pull itself no farther. At the same time the stranger sun went on its way. The farther it went, less and less was the pull it had on our sun. At last it disappeared in space.

But the stranger sun left things very different from what they had been before it came. It had pulled many small masses out of our sun. Each one of these formed a new mass of gases by itself. After years and years had gone by, these whirling masses of gas became what they are today. We call them the planets. Our earth is one of these planets.

The Sun and the Planets Make Up the Solar System

All the planets stayed together. As you can see in the picture (figure 20) the planets all move and turn around the sun. Some of them go faster than others. Some are farther away than others, but they all are held together, and they move together. For this

reason we call all of them the solar system. This name means the "system of the sun." There are four planets that are nearer to the sun than the others. The first of these is Mercury; next come Venus, Earth, and Mars. Farther away are Jupiter, Saturn, Uranus, Neptune, and Pluto.

Of course when we say near to the sun we do not mean so near that you can imagine it. Mercury, the planet nearest to the sun, is 36 million (36,000,000) miles from it. Pluto, the farthest, is nearly 4 billion (4,000,000,000) miles. Our earth is 93 million (93,000,000) miles away from it.

The planets are not all of the same size either. Figure 20 gives you a good picture of their size. The earth is 8000 miles across, so you can see how very large Jupiter must really be. It is 88,000 miles across.

In the space between Mars and Jupiter are thousands of tiny planets that look like stars. You can see them as dots in figure 20. Where do they come from? Some people believe that they are parts of a planet that was spoiled in the making. Other people believe that these tiny planets are bits of a larger planet which for some reason exploded.

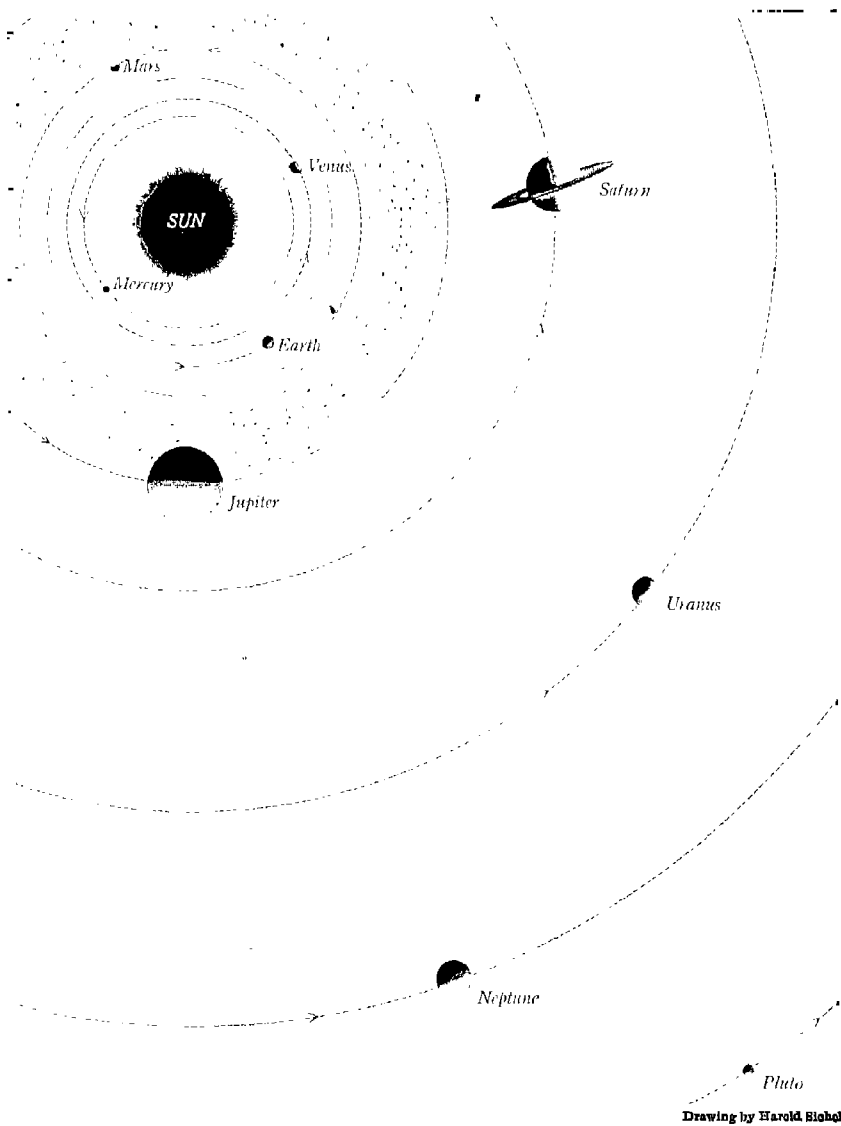


FIG. 20. Showing the planets as they move around the sun

What Held These Masses of Gas Together?

How did it happen that the masses of gas did not fly about like clouds in the sky? How did it happen that they stayed together around the sun? People have tried to answer that question for many years. They asked the same question about our earth too. Why do things stay on the earth? Why doesn't the earth fly all to pieces?

When you throw a ball into the air, it falls back to the earth again. Wouldn't you be surprised if it just kept on falling up through the air! Leaves of trees do not keep on flying up; they fall to the ground.

If you could jump over an automobile or a house easily, wouldn't it be strange? You know, of course, that these things do not happen. They never happen. Things fall *down* toward the earth, not *up*, away from it. That is what *down* means. It means *toward* the earth. *Up* means *away* from the earth.

Now the earth has the power to pull things toward it. We call this power "gravity." What this power, or "pull," is no one knows. We can only

tell you what it does. It holds the air near to the earth. It keeps the water of rivers and lakes from falling off into space. It holds houses together and the rocks of hills in place. Don't you think it is a very important power? Later you will study more about gravity.

The earth is not the only body in the universe that has the power to pull things toward it. The sun and the moon and all the stars have the same power. Each one pulls on every other one. The earth pulls on the moon and other bodies near it. The sun pulls on the earth and other bodies near it. Each star pulls on other stars near it.

There is a kind of tug of war going on all the time between the sun and all the planets and all other bodies. Figure 21 is a picture of what this tug of war seems to be.

This pulling not only holds the bodies together. It also holds them apart, so that each one can move about in its place in space. It is as though all things in the universe were held together by some great force.

The Moon Is the Child of the Earth

Those who study the universe believe that the moon was born out of the earth, much as the earth was born out of the sun. This is their idea:

During those first thousands of years after the gases were pulled out of the sun, they went spinning on their way through space. Then another accident happened. The earth was pulled closer to the sun than it is now. When it came near, the gravity of the sun stirred up great masses of gas on the earth.

Then, as the earth moved around the sun, the pull of the sun became so great that a small piece of the gaslike earth flew off and went whirling and spinning into space. This became the moon.

The moon was still held to the earth, however; for the earth's gravity was six times as great as that of the moon. So the earth and the moon went spinning and moving through space together. At the same time both of them kept moving around the sun.

So the moon was born of the earth, and both of them are parts of the solar system.

¹ Based on a drawing from *Other Worlds Than This*, by Elena Fontany. By permission of the Follett Publishing Company.

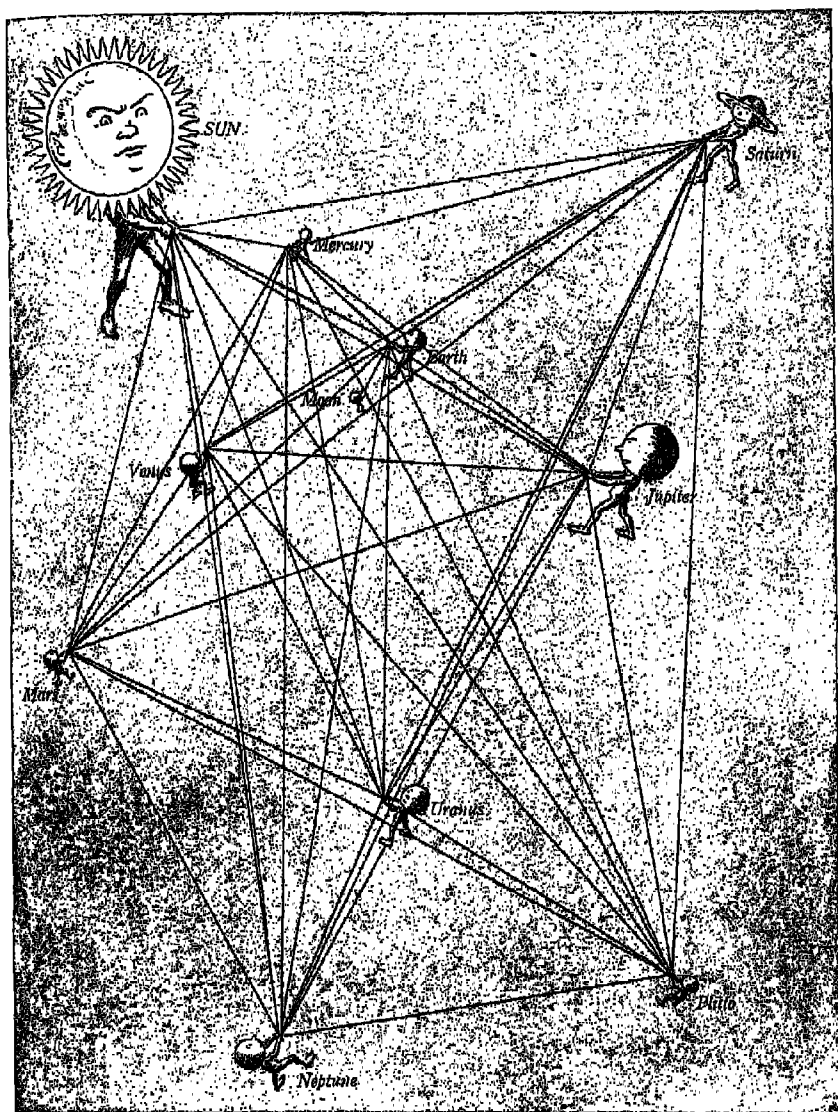


FIG. 21. The sun and the planets are held together by the pull of gravity¹

Are There Other Planets?

For many thousands of years men looked at the sky without knowing the planets. Then they began to see that some of the bodies in the universe were different from the stars. These traveled in a regular path through the sky. They called these travelers "planets." "Planet" comes from a Greek word which means traveler, or wanderer.

Mars, Venus, and Mercury were known by people long ago. Jupiter and Saturn are both so very large that they could easily be seen. But it was not until 1930 that Pluto was discovered. That is less than ten years ago.

Nobody can tell how many planets are moving in the solar system. Today we know nine of them. Perhaps some day we shall find others. Man is hunting for new things and new ideas all the time. Who knows what he may find next?

Are There Other Solar Systems?

As men begin to see more clearly into space they get new ideas about the universe. Many of them now think that in the great space are many, many

solar systems. There are many suns, with smaller bodies whirling and spinning through space, as well as traveling around them as our planets do around our sun.

The universe seems, indeed, to be made up of whirling, spinning bodies, so many that no one can count them.



Keyston

FIG. 22. This girl built her own telescope. She made the lenses and set up the whole instrument. It works very well

CHAPTER V

How We Know about the Universe

How do you think people came to know so much about the movement of the sun and the moon and the stars? By looking at them only with their eyes? No, indeed. They would have had to be very wise to guess what was happening out in space from the little they could see with only their eyes. They needed something to help them, something that would make far-away things seem very close.

It was not until men had learned to make telescopes that they began to see the stars and the moon clearly.

Did you ever look through a telescope? A telescope is an instrument that makes far-away things look larger and nearer. Figure 22 shows you a telescope which a girl made in her own back yard. Through it she can watch the stars and learn new things about the universe.

The First Telescope

In the year 1608, which is about 300 years ago, there lived in Holland a spectacle maker. Today we would give him another name, for almost nobody calls the eyeglasses which people wear spectacles. But this man made spectacles, and his name was Hans Lippershey.

Some people say that he came out of his shop one day and found his children playing in the street. They were holding up some glasses which their father had made to put in spectacles and were pointing toward the top of the church steeple.

In those days there were weathercocks on the tops of steeples. A weathercock was a wooden or iron rooster that moved with the wind, helping people to know from what direction the wind was blowing, and so what kind of weather they might be having.

"Look! How large it seems!" he heard one child say.

For a moment Lippershey listened to the excited talk, and then he suddenly got an idea. Taking the two glasses, he held them up, one in front of the other, toward the weathercock. Yes, indeed! it



FIG. 23. Lippershey's children give him the idea for a telescope

Drawing by Harold Sichel

did seem large. He could see the marks on it clearly. The two glasses, or lenses, as they are called, made things which were several hundred feet away look nearer and larger.

Later, in his shop, Lippershey took two lenses and put them in a kind of long pipe made of lead. So far as we know, this was the first telescope to be made. With it people could see far-off things more clearly than they had ever seen them before.

Several hundred years before that time a man had told how to make lenses so that things would seem larger, but it was not until after 1600 that a telescope was made.

Other men were thinking and working at the same time, and soon the idea of making telescopes spread far and wide.

Galileo Makes a Telescope

About the time that Lippershey invented his telescope a scientist by the name of Galileo was working in Italy. He was called a scientist for several reasons. First, because he looked at things more carefully than most people do. Second, because he measured things more carefully and exactly

than most people do. Third, because he could explain new ideas that people had not thought of before.

When the scientist gets new ideas about things, he studies the world very carefully to see if they are true. He measures exactly. He tries different ways of knowing. He watches what happens. Again and again with great care he does these things. In this way he is sometimes able to explain new ideas about the way things happen in the world.

Is it not clear that our scientists are among our very greatest men? They have explained many of the important things in the world to us.

Galileo was such a scientist. He saw things about the stars and moon and planets that nobody else saw. He studied these things very carefully. He measured things exactly. He explained things in new ways. He was a great scientist.

Galileo was thinking much about two ideas. One was that the earth was the center of the universe, and that the sun, moon, and stars went around it. This was believed by most people at that time. Galileo himself was not sure that it was right.

The other idea was that the earth went around the sun. A few other scientists who lived before

Galileo had had that idea, too. Galileo was interested in their idea.

But no one had proved it to be true. One of the reasons was that they could not see the stars and the planets clearly. They needed instruments with which to see them. Galileo needed them, too.

One day Galileo was traveling in one of the cities in Italy. There he heard about Lippershey's invention of a telescope. The very thing he needed! Galileo was very much excited about it. He was so excited that upon coming back to his own city he went to work to make a telescope for himself.

Galileo had not seen Lippershey's telescope; but he had such a good mind that only by hearing of the way the telescope was made, he could make one for himself. It is even said that within a few days he had made several telescopes.

Galileo not only had a good mind, but he was a good workman as well. He was able to cut and make the glass for the lenses with great care. One lens after another he made ready, and within a year he was able to make a telescope through which planets looked 33 times as large as they did when he looked at them with his own eyes.

**Galileo, the First Man To See
the Planets Clearly**

Then came the evening of January 7, 1610. For months before, from the top of a very high tower, Galileo had been pointing his telescopes at the stars. That night he sat in front of his largest telescope, looking at the sky. And that night he made a great discovery. While looking at the planet Jupiter, he saw near it what seemed like three stars. Later these were found to be small bodies going around Jupiter in the same way that the moon goes around the earth.

During the next months Galileo used most of his time looking at the sky. Night after night he found other bodies which men had never seen before.

Galileo was able to prove that the second idea was right. The earth and the other planets go around the sun. This was very different from what many people were thinking. Galileo also found spots on the sun which men had never known before. He saw the hills and valleys on the moon.

Galileo was able to explain many new ideas about

the sun and moon and stars. But perhaps one of the most important things that he did was to give to later scientists the instruments with which they could unlock the secrets of the universe.

New Planets Are Discovered

Galileo made his telescope about 300 years ago. From that time on scientists began to make instruments in different countries of the world — in Germany, in England, in France, and in other countries. Other kinds of instruments were invented too. The clock was one of these. It measured time. There was another kind of instrument that measured heat and cold. There were still other kinds. It became a great time of instrument-making.

Men also began to make better telescopes. Each new one was better than the one before. Longer and longer they became. Larger and larger lenses were ground. With each new telescope the scientists made the moon and the stars look larger than they had seemed before.

In 1781 there was living in England a man by the name of Herschel. One night Herschel looked through a small telescope at the stars in the sky.



FIG. 24. Looking at the sky through Galileo's telescope

He became very much interested in what he saw, and decided that he must have a bigger telescope so that he could see farther and watch more stars.

He went to a shop and asked how much a large telescope would be. The shopkeeper told him.

"That is much more than I can pay," said Herschel sadly, and he left the shop.

When he reached home he decided to make a telescope himself. So he bought the glass and began to make a mirror telescope. This was different from the telescopes which were made with lenses. Herschel worked for a long time. At last the telescope was finished. It was seven feet long and a little more than six inches across.

Night after night Herschel rushed home after his day's work was done to look at the stars. Often he stayed up all night so that he could watch the moving of all the bodies in the sky.

Sometimes Herschel's sister stayed up all night, too. She sat by his side.

"What do you see now?" she would say. Then Herschel would tell her what he saw, and she would write it down in a book. Many, many nights passed in this way.

One night as Herschel watched through his telescope he saw something different and strange. You know that a star looks to us like a bright point. No matter how large the telescope is, a star always looks like a bright point.

But Herschel's sharp eye saw something larger than a point. This was like a flat round plate or like a moon. No star ever looks like that through the telescope.

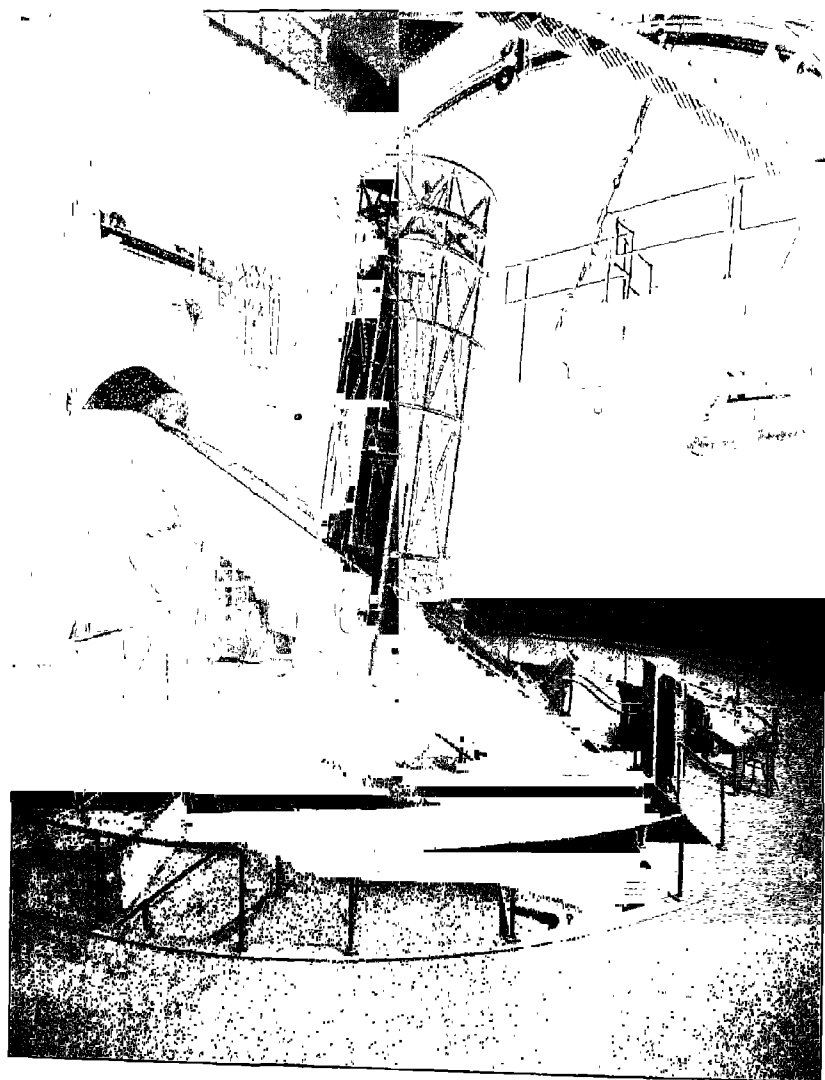
Herschel was very much excited. He called to his sister.

"I have discovered something new in the sky!" he said. "It must be a planet. But I must watch it again."

Herschel kept watching his new discovery for several nights. He saw that it moved past the stars.

Several weeks later he found that the new thing was a planet, and that it went around the sun just as our earth does. Later the planet was called Uranus. Herschel also found that there are four smaller bodies going around Uranus, just as the moon goes around the earth.

That is the way another discovery was made.



Mount Wilson Observatory

FIG. 25. The telescope at Mount Wilson Observatory, in California. This is one of the largest telescopes in the world

The Wonders of Telescopes Today

The story of the telescope began several hundred years ago and goes on and on every day. It is the story of men who have thought and worked so that we can understand more about the universe.

Today there are giant telescopes that are able to show the planets and stars many times larger than they seem to our eyes. Figure 25 shows one of the largest in the world today. This telescope is found in an observatory in California. An observatory is a building from which people look at the sky through telescopes. The mirror in the telescope is 100 inches across.

But even today men think that they have not looked far enough. While this book is being written the newspapers and the movies tell us that scientists are building a telescope whose glass is 200 inches across.

When the mirror is finished, it will be sent to a mountain top in California and put into a great observatory. This will make men able to see four times as far as ever before. What do you think men will discover as they look through this telescope?

CHAPTER VI

Spinning from Night to Day

"I SEE NOW," said Nancy, "why the sun is called the father of the earth."

"Yes," said Dick, "but it is the father of Jupiter and Venus and Mars —"

"And the other planets," added Jane.

All the children began to talk about the sun.

"The sun shines and shines all the time," said Nancy. "It shines on everything that is near it."

"Near it!" Tom cried. "What do you mean, 'near it'? The sun is 93 million miles away from the earth."

"Yes," said Nancy. "But, after all, that is really near the earth. At least it is if you think of how far the sun is from some of the other planets. Pluto is nearly 4 billion miles away from the sun."

"Think of how far away some of the stars are. Why, they are millions and millions of times as far away as our sun."

Just then Charles came in with a book about the stars.

"I read that a train running 50 miles an hour would take about 200 years to reach the sun," he said.

"I can't think of so many years," said Tom.

Miss Brown smiled. "We can say that the sun is 93 million miles from the earth, or we can say it is 200 years from the earth by train. That tells us how far the earth is from the sun. Now let us think of the size. Is the sun as large as the earth?"

"Oh, yes, much larger," called out several children.

"How much larger is it? Ten times? One hundred times?"

"Thousands of times larger," said Charles. "This book says that it is almost a million times as large as the earth."

Later that day the children were having a meeting with Miss Brown.

"I found a poem about the sun," said Nancy. "It says:

"Shine! Shine! Shine!

Pour down your warmth, great sun!"

"That means that the sun makes us warm, doesn't it?" asked Sally.

"Yes, the sun gives us heat," said Miss Brown. "Much more heat than people can make by burning wood or coal or oil. Without the sun we should have no heat."

"Then we should freeze," said Tom.

"Everything would freeze," said Miss Brown.

"I found a poem too," said Dick. "It says:

"The sunshine has a pleasant way
Of shining on us all the day,
It makes the little window bright,
And fills the room with pretty light.

"It goes into the garden bed,
And shines on every flower head;
It warms each leaf and bud and seed
Till all the world is glad, indeed."¹

"Does that poem tell you why we like the sun?" asked Miss Brown.

"The sun makes everything bright," said Jane.

"And fills the room with light," added Dick.


"It fills the whole sky with light," said Jane.

¹ Annette Wynne, *For Days and Days*, p. 33. F. A. Stokes, New York, 1919.

"Yes, the sun gives us light as well as heat. Can you see now why people who lived long ago loved the sun and called it a god? They did not know what the sun was, but they did know that it was important for everything on earth."

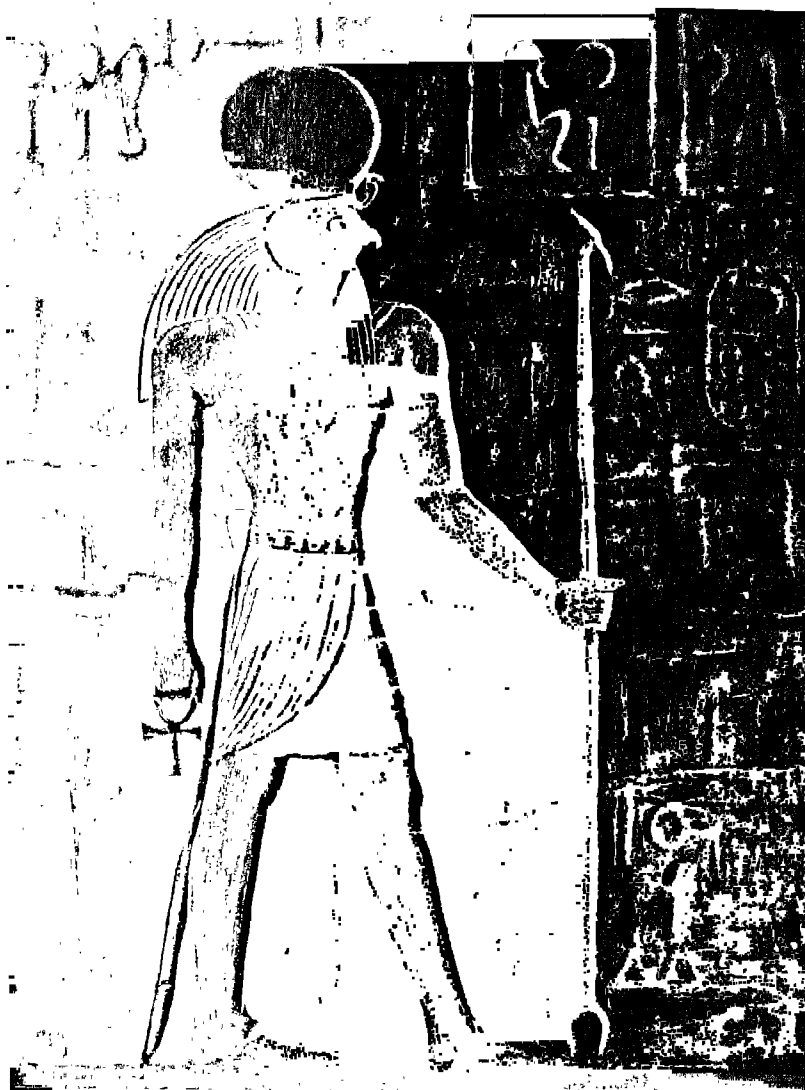
The Sun God of Egypt

Almost 5000 years ago there were people in Egypt who had a sun god. His name was Ra. Figure 26 shows one of the pictures which the people of Egypt made of him. He had the body of a man and the head of a bird. On his head is the sun, like a plate, with a snake around it. This snake stood for the king in Egypt. The rod in his hand also stood for the power of the king.

Above Ra's head is his name written in pictures. This circle with the dot inside  is still used by some scientists when they wish to show the sun.

The Greek Sun God

The Greeks also had a god of the sun. He was the strong Apollo, who drove his horses across the sky every day. Figure 27 shows him driving his horses across the sky.



Drawing by Forrest Orr

FIG. 26. This is how the Egyptians thought Ra looked



Drawing by Forrest Orr

FIG. 27. This is how the Greeks thought that Apollo, the sun god, drove his horses through the sky

Most people of long ago thought the sun was very wonderful. In every country they knew that if the sun were not in the sky, there would be no trees or flowers or people on the earth. Even today we give one of the days of the week to the sun by calling it Sunday.

Night and Day and the Sun

As Nancy said, the sun shines and shines all the time. Why is it that we do not see it all the time?

You know that the earth spins round and round like a top. You can understand how the earth spins if you think of a line running through the earth. The earth spins around this line. Of course there is no real line running through the earth, but we can imagine that there is. We call this line, which we imagine, the *axis*. We say that the earth spins on its axis.

At one end of the earth's axis is the *north pole*. At the other end is the *south pole*. These are the names given to the ends of the axis.

When we wish to measure places on the earth, we imagine another line as being there. That is the *equator*. It is drawn around the earth exactly

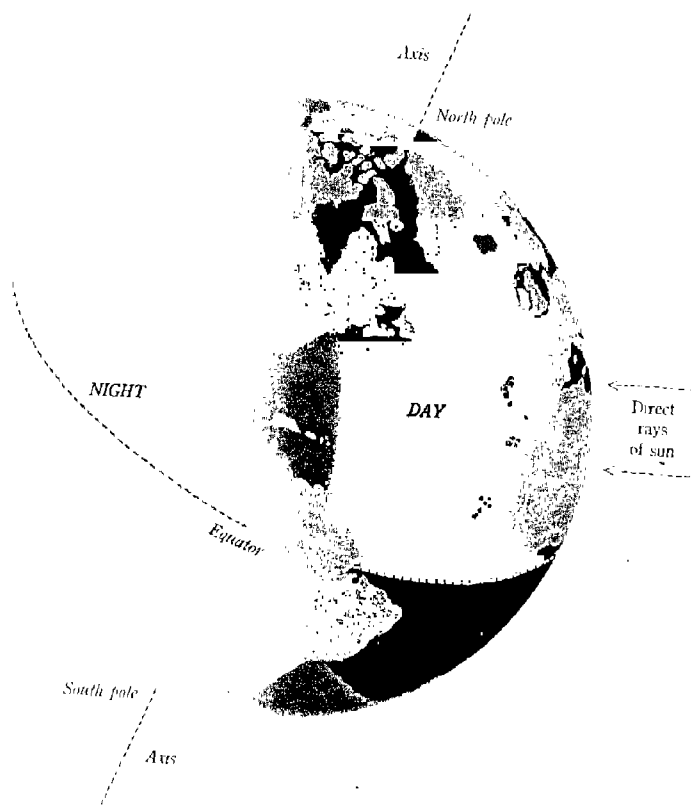


FIG. 28. The sun is sending its light from far away. The light shines on half the earth, giving us day. The other half of the earth is turned away from the light. The people on that side of the earth are having night

Drawing by Harold Siegel

halfway between the two poles. It divides the earth's surface into two parts. The part that is toward the north pole is called the northern half; the part toward the south pole is called the southern half.

Of course neither of these lines is really there. We only imagine they are there. But we must know them so that we can tell which way the earth turns and other things about it.

The earth keeps spinning on its axis. When the sun shines on the part of the earth where we live, it is day. When the earth has turned until we are away from the sun, it is night. Then we are asleep, and the people who live on the other side of the earth are awake.

This is the way one great poet tells us how he sees the earth having night and day:

I see a great round wonder rolling through the air,
I see the shaded part on one side where the sleepers
are sleeping
And the sunlit part on the other side.

"Let us show how it is that we have night and day," said Miss Brown. "Let's suppose this light is the sun."

Miss Brown held out a bulb to two children. Tom took the bulb and threw light upon a school globe with it. Mary slowly turned the globe from *west to east*. Dick held his finger on a spot on the globe.

"Now it is morning. We are just beginning to see the sun."

"That's what you mean when you say the sun is rising, isn't it?"

"Yes. Now it is the middle of the morning. Now it is noon. The sun seems right overhead."

They turned the earth on and on away from the sun, through the afternoon. Soon they could just see the sun as it seemed to go down in the west. At last Dick's finger on the globe was on the other side of the earth from the sun. His part of the earth was dark.

"Now it is night," said Tom. "We are sleeping."

"Yes," said Miss Brown. "You have shown now how it is that we have night and day."

"It is really wonderful!" said Jane. "Everything on the earth looks as though it were standing still. And yet everything is really moving fast all the time."

"I would rather think of the sunrise and the sunset," said Nancy. "There are so many poems about them." Nancy was always looking for poems.

"Here is one about the sunset," she said.

SUNSET

Like some huge bird that sinks to rest
The sun goes down — a weary thing —
And o'er the water's placid breast
It lays a scarlet outstretched wing.¹

So you see that the earth spinning on its axis gives us night and day. When people on the earth are facing the sun, it is day for them. When they are not facing the sun, it is night for them.

The Sun and the Seasons

One day in June the children gathered around the sheet of paper that they had put up on the wall. Each day they set down on this sheet of paper the time of sunrise and sunset.

"The days are getting much longer," said Nancy.

"Yes, the sun rose yesterday at 4.22 and did not set until 7.41 o'clock."

¹ Herbert Bashford. By permission of Houghton Mifflin Company.

"That was over fifteen hours," said Miss Brown. "Last year, on the twenty-first of December, the day was very short. The sun did not rise until 7.26 o'clock, and it set at 4.30 o'clock in the afternoon. That was only about nine hours."

"I notice something," said Tom, who had been studying a book about the sunrise and sunset.

"What is that?" asked Miss Brown.

"Days are always longest in June and shortest in December."

"Yes, after Christmas they begin to grow longer. All through the spring the sun rises earlier and earlier and sets later and later."

"Yes," said Mary; "and after June 21 the sun rises just a little later each day and sets a little earlier. All through the autumn the days are growing shorter and shorter."

"Could we say, then," asked Miss Brown, "that during the spring the days grow longer, in the summer they are longest of all, during the autumn they grow shorter, and in winter are shortest of all?"

"Is that what you mean by the four seasons," asked Charles, — "spring, summer, autumn, and winter? Are there always four seasons every year?"

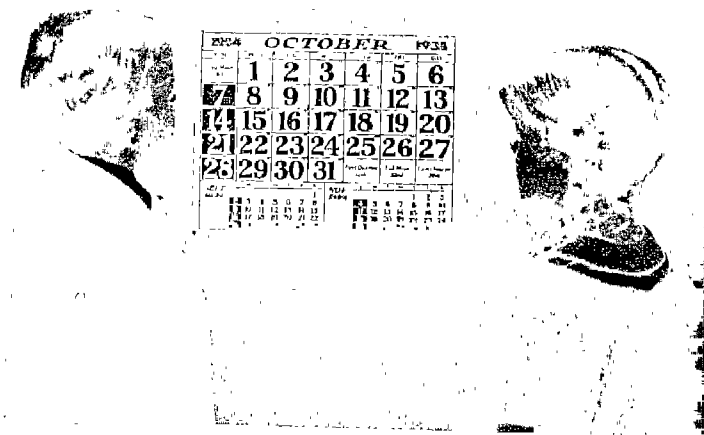


FIG. 29. These children are trying to find what day of the month it is

“Yes, on our part of the earth, year in and year out, there are always four seasons.”

One poet has thought of the seasons just like a day. Here is the beginning of his poem:

Spring is the morning of the year,
 And summer is the noon-tide bright;
 The autumn is the evening clear
 That comes before the winter's night.¹

¹Frank Dempster Sherman, *Little Folk Lyrics*, p. 22. Houghton Mifflin Company, Boston, 1897.

"But how do we happen to have four seasons?" asked Tom.

"Here is the story," said Miss Brown.

Remember, first, that the earth not only spins on its axis, but moves around the sun at the same time. On and on it goes, spinning and moving, spinning and moving.

The next thing to remember is that the earth is tipped. It does not spin upright like a top on the floor. It is tipped, as if it were bending over, and the north pole is always pointing in the same direction.

As the earth moves around the sun, it happens that at some times during the year the north pole is pointed toward the sun and at other times it is pointed away from the sun. You can see from figure 30 how this happens.

On June 21 the north pole is tipped toward the sun. The part of the earth north of the equator is having summer.

The earth keeps moving in its path around the sun. On and on it goes, whirling and moving, with the north pole always pointing in the same direc-

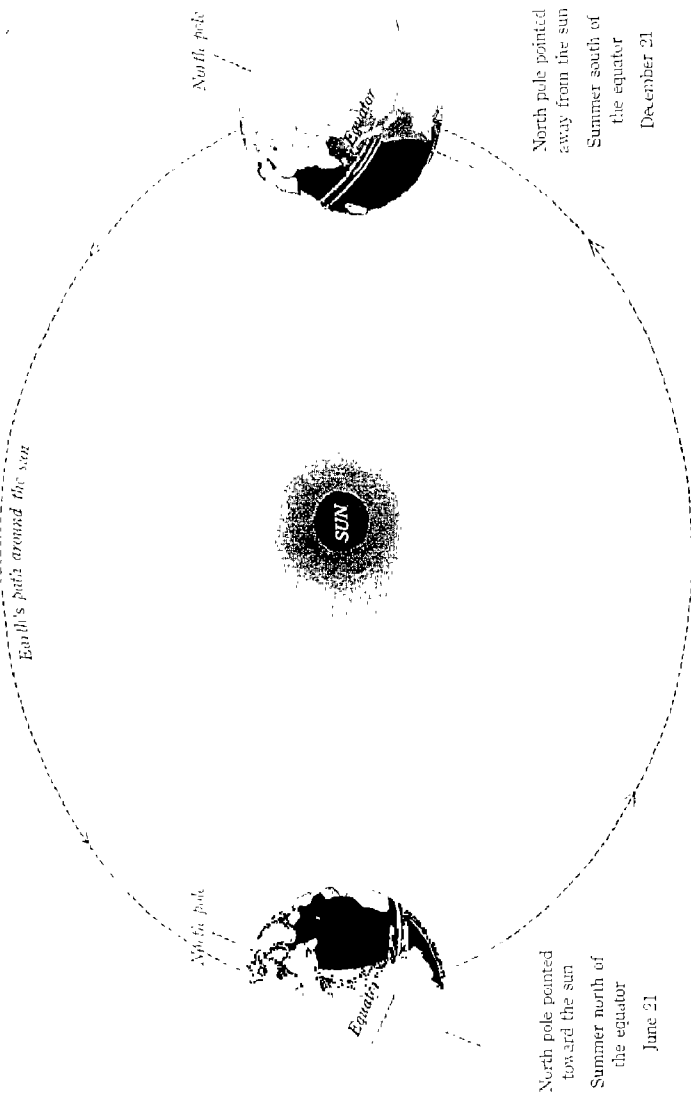


FIG. 30. The earth in its path around the sun. Notice that it is tipped in the same direction all the time. When the north pole is pointing toward the sun, it is summer north of the equator; when it is pointed away from the sun, it is winter

Drawing by Harold Siebel

tion. On December 21 the earth reaches the place in its path where the south pole is pointing toward the sun. The part of the earth south of the equator is having summer.

But the earth goes on and on. Soon the north pole begins to point toward the sun again. By June 21 it is pointing directly toward the sun. Summer is in the north again.

The earth has gone round the sun. It has taken $365\frac{1}{4}$ days. We call it a year. Then the story begins again — spring, summer, autumn, winter — and goes on without end.

One poet has thought of the year as changing. This is what he says:

THE CHANGING YEAR¹

Summer, autumn, winter, spring —
Back and forth the seasons swing;
Sun and snows returning ever,
Like the wild geese on the wing.


So you see how the earth and the sun make us change our lives in many ways. When we have day, the sun warms the earth and gives us light.

¹ Lloyd Roberts, in Burton E. and Elizabeth B. Stevenson's *Days and Deeds*, p. 398. By permission of the author.

At night it is dark, and we go to sleep in our beds. When the north pole is tipped away from the sun, our part of the earth is cold. It is winter. We close our doors and burn our fires to keep warm. We wear heavy clothing. Plants are asleep, and nothing grows.

In summer we open our doors wide and play outside as much as we can. Trees and flowers are in bloom, and the corn waves in the fields.

As the poet said, sun and snows are returning always, like the wild geese on the wing. The year brings us changes, and we change with it.



CHAPTER VII

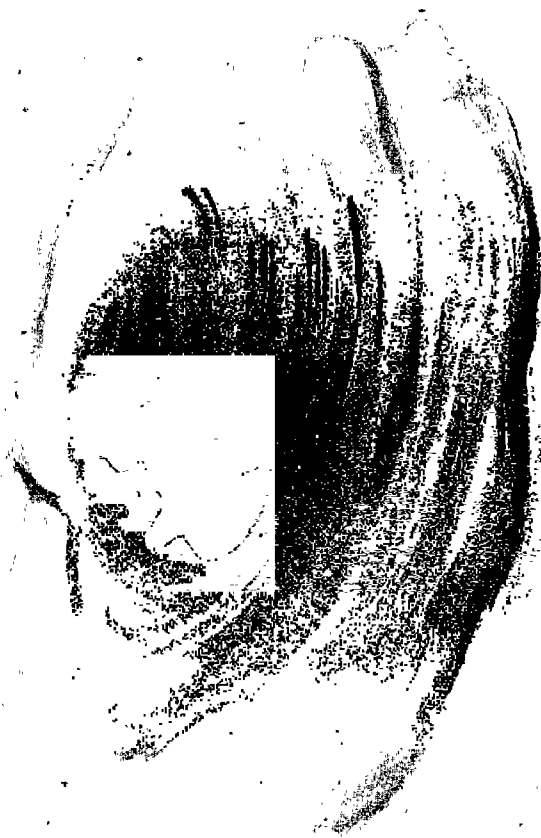
From Sun Dust to Solid Earth

WE MUST go back a moment to the story of how the earth was born. You remember that the passing stranger sun pulled great masses of gas from our sun. These became the planets, and the earth was one of them.

The planets kept spinning and whirling while always moving around the sun. The gravity pull of our sun held them there so they did not fly off into space. Neither did they fly back to our sun. The great tug of war between all the sun-stars held the earth and the planets in their places.

Millions of years passed. The earth kept whirling and spinning, a giant mass of hot gas and dust moving and turning at great speed. After all these years this whirling mass of gas became our earth, a great round ball made up of rock, soil, water, and other materials.

How did this strange change come about? We



Drawing by Harold Sticht

FIG. 31. The earth kept spinning and moving, a giant mass of
gases and dust

do not know exactly. Scientists have explained it in several ways. Here is one of them.

The Earth Cooled

The sun dust was very hot—as hot as the sun itself and much hotter than anything we know today. But the vast space around it was cold—colder than anything we know.

As the earth gases whirled in cold space they began to cool. As they cooled, some of the masses of gas and dust held together. They became solid. Some people think that these hot clouds of gas and dust came to be like clouds of little hailstones. These clouds of hailstones became bigger and bigger.

In the center was a much larger mass that became harder and harder. And always it was spinning. By its gravity it pulled the clouds of dust and stones down to it. Its gravity also held some of the gases around it. Bigger and bigger it grew.

More millions of years passed, and during this very, very long time the earth became harder and harder. At last the outside became hot solid rocks. These were cooler than the masses of gas, but they

were still so hot that the whole earth was light. Its own heat made the earth light.

A Hard Crust Formed

Then more millions of years passed. More and more the earth cooled. And while the earth was cooling, it grew smaller. The outside formed a cold hardening crust. But the inside was still hot melted rock; and as the crust cooled and grew smaller, the inside must have boiled and boiled.

Sometimes the melted rock broke through the crust and poured out on the surface of the earth again. How often this happened in all those many years that passed we do not know. Many times, we think, the crust of the earth cracked open and let out more hot material. At other times the earth's crust moved, making an earthquake. There must have been many earthquakes, greater than the ones we know today.

But the crust, which had been hot melted rock, became solid cold rock. At last the rocks became so cold that they stopped giving out light. And then the earth itself was dark, to be lighted only by the sun.

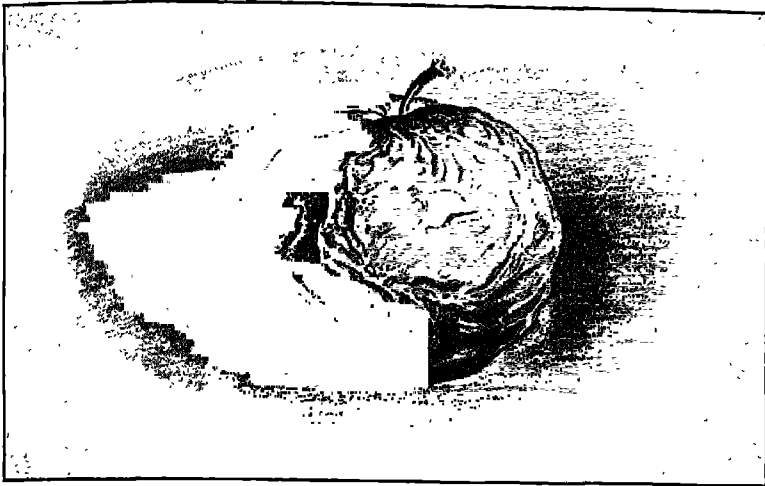


FIG. 32. The crust of the earth wrinkled just like the skin of this baked apple

How the Mountains Came To Be

For millions of years the earth was cooling and the crust was forming. As it cooled, the crust wrinkled, just as the skin of a baked apple wrinkles when it is taken out of the oven (figure 32).

In many places the wrinkles became so large that they folded over on the others. These were giant folds, and they moved one on top of another, just like layers in a cake. Some layers rose higher than others.

Then too when the earth was shaken and cracked, great masses of rock slid around in many different ways. They smashed and pounded and broke and lifted. So the mountains came, and the valleys between them. After a long, long time these mountains slid around again. Great blocks of rock and earth were pushed into other blocks. New mountains and new valleys were formed.

Some scientists say that the outer crust of the hard rock was very heavy. Now and then, after millions of years, some of the heavy parts of the earth's crust pushed down into the melted material inside. By pushing down some parts, other parts of the crust were pushed up into the air. The rocks that were pushed up formed the mountains; the deep places formed the valleys.

How do we know that the crust of the earth was changed many times? We know this because we can see the folds and layers and wrinkles in many parts of the earth today. Figure 33 shows how they look. Some of these folds are nearly flat; others stand up quite straight in the air. Does not this show that they must have been pushed up into the air by some giant force?

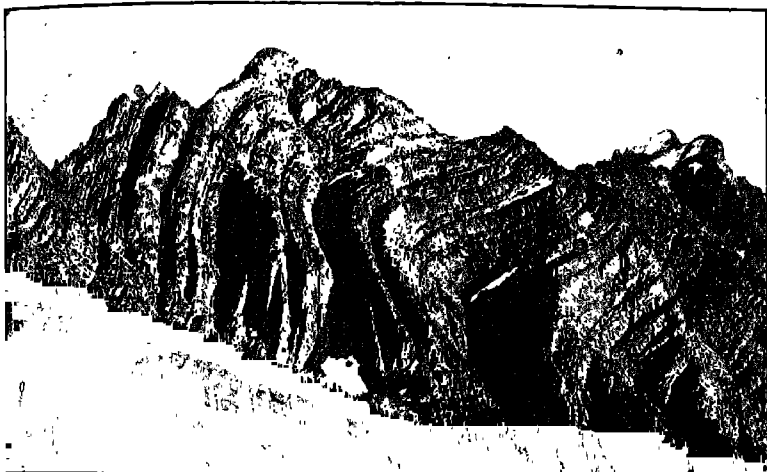


FIG. 33. The wrinkles became very large. They made giant folds in the earth

Sometimes the force was so great that the whole mountain was moved a long way. One of the Alps in Europe was moved 50 miles! Another mountain, in the western part of the United States, was moved 15 miles.

Many others have been moved too. We know this because the rock and soil of these mountains are not like the rock and soil of the land around them. Instead, they are like the rock and soil of the land many miles away.



FIG. 34. The waters came down upon the crust of the earth

And the Waters Came upon the Earth

As the earth formed, a thick blanket of gases covered it all around. The earth was spinning fast, but this covering of gases did not rush off into space. The gravity of the earth held it close to its surface. How thick this covering of gas was we do not know. Perhaps it was hundreds of miles thick.

In this blanket of gas were great clouds of mist which we call vapor. When these clouds touched the cooling outer crust of the earth, they came together and formed drops of water. Then they fell on the earth as rain.

So it was, perhaps, that the first rainstorms happened. So it was that the first water came down upon the outer crust. We can imagine that all those clouds became drops of water. Storm after storm must have come, pouring its rain down upon the rocky earth.

Down on the mountains dropped the rain. Because of the earth's gravity it always rolled down to the bottom of the valleys between the mountains and hills. Down and down it flowed, as "rivers" of water.



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FIG. 35. On and on went the waters in the mountains

Some of the water was caught in holes and low places. Other streams passed on, becoming larger and larger as more and more water ran into them. On and on went the brooks and the rivers, working their way down the cracks in the mountains and along the flat places. At last they came to the lowest valleys of all. There, year after year, for millions of years, the water gathered.

Lands and Waters Formed

So it was that part of our great earth became land and part became water. Look at the globe which stands in your classroom. Look at the map of it in figures 36 and 37. Study its whole surface.

Do you see that part of it is made to show the lands and part of it to show the waters? About one fourth of the earth is land and three fourths is water.

The large masses of land are called *continents*. There are seven continents. Find them on your globe. Find them also on your map (figures 36 and 37). They are:

North America, where we in the United States live.
Asia, the largest continent, where half the people of the world live.

Europe, the continent with many people. Europe is really a part of Asia, but it is so important that we call it a continent.

South America, a large continent with few people.
Africa, a large continent, the home of the dark-skinned people.

Australia, a large continent with very few people.
Antarctica, the land at the south pole, with no people.



FIG. 36. The continents and oceans of the western half of the world

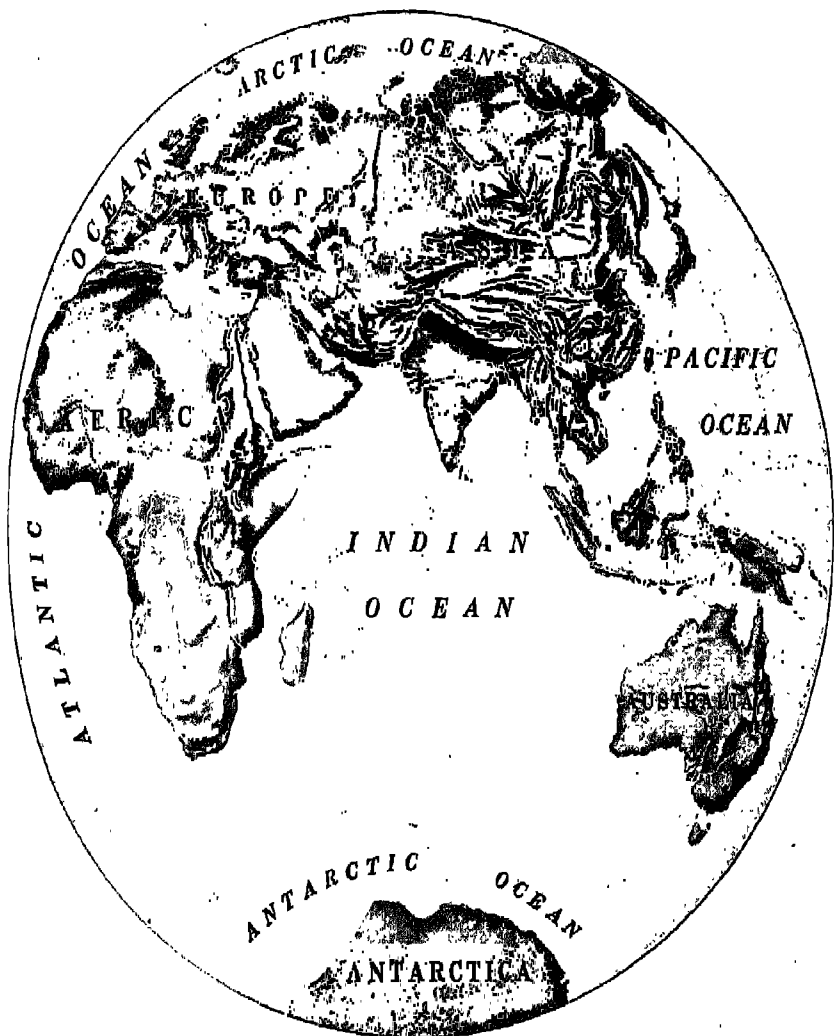


FIG. 37. The continents and oceans of the eastern half of the world

The large bodies of water are called *oceans*. There are five oceans on the earth. Find them on your globe. Find them also on your map (figures 36 and 37). They are:

The Pacific Ocean, the largest ocean of all. It is between North America and Asia and between South America and Australia.

The Atlantic Ocean, between North America and Europe and between South America and Africa.

The Indian Ocean, the smallest ocean, south of Asia.

The Arctic Ocean, around the north pole.

The Antarctic Ocean, around the land at the south pole.

Of course there are many smaller masses of land. Some of these we call islands. They have water on all sides.

There are also many, many smaller bodies of water. Some of these are called seas and some are called bays and some lakes.

We shall study these later.

You can also think of the continents and islands as being the high lands of the earth. They are the

lands that stand up high enough to reach above the oceans and the seas.

The rest of the earth is low land — so low that three fourths of it is under the waters. In some places the lands reach down several miles below the water. We say then that the ocean is several miles deep.

In some places, of course, the ocean is much deeper than in others. Near the coast, as at the beach, it may be only a few feet deep. It is safe for us to swim in it. Farther out it is thousands of feet deep. There is what is called a "deep hole" out in the Pacific Ocean that is seven miles deep. It is seven miles down to the mud bottom of the ocean.

What the Oceans Do for Us

Are you surprised to learn that only one fourth of our earth is land? All the rest is water. Are you troubled by that? You need not be. It is really good for us that water covers three fourths of our globe, for it helps to warm the lands. Then, too, the water in the oceans is taken up into the air as vapor. The clouds of vapor come together and form drops of water. The water again comes down on the earth

as rain. Without this rain we could not grow things in the ground.

So the oceans do fine things for us. They really help to keep us alive.

The Continents and the Oceans Have Changed Many Times

There were times long, long ago when the continents were larger and the oceans smaller than they are today. Their shapes were very different, too. Time after time old mountains wore down and new mountains were pushed up. Some of the lands fell into the oceans. The waters rushed in over the lands and formed new oceans and new seas.

This happened many, many times. But after each time years and years may have passed before it happened again. Today these changes are taking place slowly. We cannot see many of them, but they are happening all the time.

A Blanket of Atmosphere Was Formed around the Earth

One other thing happened as the hot mass of gas cooled and hardened and became the rocky

earth. A thin covering of atmosphere, or air, was formed around it.

You know how important air is to people. Try to hold your breath. Notice after a short time how very strange you begin to feel. Without air to breathe people die. Without air animals die. Without air plants die. Every living thing must have air to breathe.

What is this blanket of air, or atmosphere, around the earth? It is made up of several things. Some of these are gases. You will study about them in your later school work. There are also water vapor and dust and a very small number of other things.

On bright sunlight days you can see bits of dust in a ray of sunshine. On foggy days you can see the water vapor in the atmosphere. The gases you cannot very often see. But they are there just the same, even if you do not see them.

How did the earth get its atmosphere? That is another question which we cannot answer exactly. This is what scientists think:

When the earth was cooling and hardening, some of the gases stayed with the whirling mass. As you know, the earth was very small at first. At that



FIG. 38. After millions of years the earth became as it is today—
a great round ball made up of rock, soil, and other materials

Drawing by Harold Stehal

time its pull was not very strong. Much of the gas was pulled away from the earth toward the sun and the other stars. But after a long time the earth became bigger and held more and more of the gases close to it.

Many times, as you know, the crust broke and cracked, and gases from the inside of the earth came out. These were added to the blanket of air around the earth. Later the covering became what it is today.

At the surface of the earth the air is thicker than it is far away. We know this because when people climb a mountain they find it harder to breathe as they go up. They say the air gets "thinner." On very high places the air is too thin for people to breathe. Aviators who have flown eight miles high have had to carry with them some of the thicker air to breathe.

Most scientists think that the atmosphere does not reach higher than 100 miles. A few of them think it may be as thick as 200 or 300 miles. Higher than that there is no air. After all, that is really a thin blanket of air if we think of the miles and miles of space.

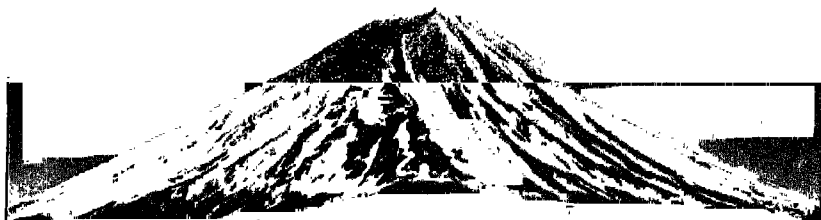


FIG. 39. To the people of Japan, Mount Fujiyama is the most beautiful mountain in the world

Toyo Okamoto

CHAPTER VIII

Mountains and Men

ALWAYS PEOPLE have looked up at the tops of mountains and thought how beautiful they are. They have seen the snow covering their tops and the clouds hanging round their sides. They have heard the rush of water running down among rocks and trees, and the roar of waterfalls as they plunged over steep rocks.

For long years men said mountains belonged to the gods. The Greeks, for example, thought that the king of their gods lived on Mount Olympus and that the other gods came to meet there with him to help him rule over the world. Mount Olympus still stands, stretching high into the sky.

In China, too, there are such mountains. One of these is more than 10,000 feet high. Scattered everywhere on the sides of this mountain are beautiful buildings—the churches of those who wish to go to pray to the god.

Mount Fujiyama, in Japan, is a much-loved mountain. Everyone speaks of it as Fuji, and everyone at some time or other wants to climb to its very top.

Every summer thousands of Japanese climb up the mountain roads. The five paths are long but not dangerous. All the people are dressed in white. After walking for a long time they stop and have tea and rest for the night. In the morning they go on. At the top they find huts of stone, for in the winter great storms blow across the mountain and the snow is piled high, and any people who climb the mountain then will need shelter.

Almost everything in Japan shows us how much the Japanese love Mount Fujiyama. It is painted or drawn upon hundreds of things which they use. It is painted on fans. China, wood, and silk are also made beautiful with it.

Sometimes people were afraid of mountains. They were afraid because the mountains were so high and so big. The Germans long ago believed that witches and goblins lived in the mountains of Germany. On a certain night these witches and

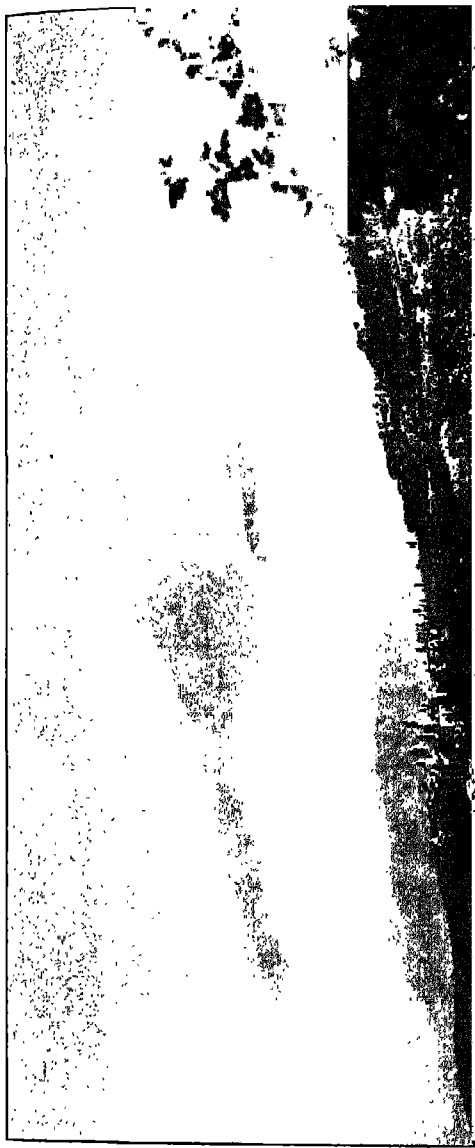


FIG. 40. The Greeks called this a friendly mountain. Can you tell why?

goblins would come out and dance among the hills. All the people stayed in their houses that night for fear that the witches would come and get them.

To some people of long ago certain mountains seemed to be friendly. Such a mountain was Athos (figure 40), in Greece. The top of Athos reached above the clouds. When sailors were out at sea, they looked for Athos to show them their way and to lead them safely home. They thought of it as a friendly mountain.

Here are the names of some of the very highest mountains in the world.

Mont Blanc is more than 15,000 feet high. It is one of the Alps, the largest row of mountains in Europe.

Mount Everest is one of the Himalayas in Asia. It is about 29,000 feet high.

Mount Aconcagua is one of the Andes, which stretch along the western edge of South America. It is nearly 23,000 feet high.

Mount McKinley is in Alaska, in North America. It is about 20,000 feet high.

Each of these is in a different continent of the earth. Find each one on your globe.



Ewing Galloway, N.Y.
 FIG. 41. Mount McKinley is the highest mountain in North America. Many people have tried to climb it, but few have ever reached the top



Ewing Galloway, N.Y.
 FIG. 42. Mount Everest is in Asia. It is said to be the highest mountain on the earth. People have flown over it, but no one has climbed to the top

Figures 41 and 42 are pictures of two of the four highest mountains in the world.

Man's Hunger To Climb the Mountains

Men have always wanted to climb the mountains around them. In every continent they have tried to do it. Some of them have felt that they must climb and climb until they reached the very top of a certain mountain. Others have wanted to look as far as they could see from one mountain, and then go and climb the next mountain.

Here is the story of one of the first men to climb Mont Blanc.¹

From the time Balmat was a small boy he had wanted to climb the mountain. By day he thought of nothing else. At night he dreamed of it. When he became older he worked hard to fit himself for the climbing. He would walk for three whole days with nothing but snow for food.

In the year 1786 Balmat was a young man 25 years old. One day in that year he set out with his knapsack on his back and a stick in his hand. He

¹ Adapted and quoted from Jean-Henri Fabre's *This Earth of Ours*, pp. 194-197. D. Appleton-Century Co., New York, 1923.

climbed and climbed until he came to the place where the ice fields began. On and on he went, crossing the fields of snow and ice.

Late in the day Balmat reached a flat stretch of hardened snow. Soon his eyes began to ache. The light from the snow had been too bright. Then his head felt queer and he could not see clearly. There was only one thing to do. He must find a hole in the snow and stay all night.

He set down his knapsack and began to get ready. After keeping his eyes closed for some time, he opened them and saw that the sun was setting. Over his head the sky was very black. Against this blackness the tip of Mont Blanc stood out white as a sheet.

Far below a large red ball appeared, swimming in a shining furnace. It was the sun setting. For a moment Balmat did not know what it was. The red ball seemed to be sinking into the earth.

Then, hundreds of feet below, clouds began to gather. Higher and higher they were lifted, like the waves in the ocean. Soon the shadows began to come up from the valleys, covering, one by one, the snowy mountain tops below him. Higher and higher

the darkness rose. It seemed like thick smoke, covering everything. At last it was all around him.

The top of Mont Blanc, like an island of light in a sea of darkness, shone with its whiteness. The last rays of daylight began slowly to leave the snow-covered mountain, and then all was darkness. Night had come.

Now he began to be afraid. Not a sound was heard anywhere. To drive away his fears he began to sing. His voice sounded so weak and so strange that he stopped singing. Then he took some food out of his knapsack. It was frozen. The bread was as hard as stone.

Down below the lights began to appear, one by one, in the houses in the village. Then they disappeared.

The cold was so great that if he had stayed still for fifteen minutes more he would have been frozen. It was only by beating his sides that he kept warm. His strength was leaving him. His head seemed to be tight. A heaviness was creeping all over him, and he wanted to sleep. He got sleepier and sleepier, but he tried with all his might to stay awake. He knew that if he went to sleep he would never wake again.



Ernst Galloway

FIG. 43. A mountain climber is crossing a deep crack in the ice and snow of the Alps

So far the sky had been clear. But soon a soft snow began to fall. Balmat covered his face with his handkerchief. In a few seconds his breath had frozen on the handkerchief. His clothes, wet through with snow, were coated with ice. The wind rose, not strong, but so cold that under the handkerchief his face felt as if needles were sticking into him. He put his hand on the painful spot, and when he took it away his fingers had drops of blood on them. Under the biting cold the skin had cracked like old bark on a tree.

Suddenly a loud cracking made the mountain shake. Next there came the sound of something slipping and sliding. Then everything seemed again as though dead. Balmat knew what the sound had been. It was a river of snow, a glacier, that had slipped and was sliding down the mountain side. Several times during the night these loud cracks were heard. Balmat thought that he might be buried under the snow that was sliding down from above.

Fear had nearly mastered him. The cold had stiffened his limbs. At last, about two o'clock in the morning, a sign of daylight came to give him hope. It was high time, for another hour or two of

that fearful waiting would have finished him completely. He got up and rubbed himself and began to go on.

Up the mountain he went, where the snow was so hard and so slippery that he could not stand up. However, by making holes with the iron point of his stick, he was able to hang on. But that was hard work, and soon he began to get very tired. He felt that he was dying with cold, and so he decided to return.

He turned around and went back to the village. His face was blue and swollen. The skin was all cracked and blistered, and his eyes were red. When he reached home he shut himself up in the barn, threw himself down on the hay, and slept for 48 hours.

A month later, August 7, 1786, Balmat started again for Mont Blanc. This time he went with one of his friends. The story of their climb is a very exciting one. Many times they were so tired that they thought they would have to turn back. But Balmat kept them going, and at last they were at the top of Mont Blanc. No living thing had ever before set foot there.

The Aviators Really See the Mountains

One of the wonderful joys of climbing mountains is that you can see farther and farther. At each step more of the earth comes into sight.

But the airman can see all the picture at once. Admiral Byrd says that every hour when he was flying over the continent at the south pole, he could see 6000 square miles of new land. Far away he caught sight of a beautiful mountain. Then another and still another came into sight, till he had counted fourteen new mountains that had never been seen before by anyone.

Seeing the sunrise in the mountains is also one of the most beautiful pictures which the aviator sees.¹ Through the gray of the morning the sun's flames show suddenly above the mountain. The light begins to pour over the wings of his machine. The tops of the mountains are touched with fire. Red mist rises up from the valley.

Flying among the mountains, in and out among their tops, is a hard thing to do. Once a young

¹ Adapted from Peter Supf's *The Airman's World*, pp. 107, 116-117. William Morrow & Company, Inc., New York, 1933.



Captain Ashley C. McKinley

FIG. 44. Flying over the mountains at the south pole. Can you see the wing of the plane above?

aviator was flying home from Italy in a small fast plane. He decided to cross the Alps. But the mountains were covered with clouds. The trip would be dangerous, so he flew far above the clouds, trying to see the way through.

"The clouds below me are not very thick," said the airman to himself. "I think I can drop through them and land in the valley." So he dropped 5000 feet. That is almost a mile.

Then he went on. Now all around him everything was black — as black as night. Soon it began to snow. The snow fell heavily. The aviator began to wonder if he was flying upside down.

Suddenly a dark shape came up before him. A moment later it was gone. Then a black wall of rock flew past. He was flying through snow and fog in the mountains.

He knew then that he was in terrible danger. Bravely he tried to lift the machine, but before he knew what was happening he had struck the earth.

For a long time the young man lay as if dead. When he waked up he found himself lying in five feet of snow. He was safe. The snow had broken his fall. Shaking off the snow, he looked about him.

There was the plane above him, what was left of it, on a shelf of the mountain.

To get away from the icy night the aviator lay on his back and slid down the mountain. Suddenly he heard a roar above and saw that the whole mass of snow was moving down the mountain also. Was there nothing he could do to save himself? Faster and faster it went, carrying him with it.

Then he saw a pine tree in his path. He took hold and hung on to it with all his might until the mass of snow had slid past him down the mountain. Then he slid down too, without more trouble. Later he made his way to a town and was safe.

What Men Find in Mountains

Not only are the mountains beautiful to look upon; not only are they exciting to climb; they also have in them things men want to use.

As you know, when the earth cooled, it became hard. Rocks and stones were formed. There are many kinds of rock. Some are very hard and some are soft.

People have learned to use rock in many ways. They use hard, white rock for beautiful buildings.

They use the strong granite in making bridges and for tall buildings in cities. They use different kinds of softer rocks for houses, too. Even the rough small stones of the fields are sometimes used to make stone houses.

When the white men first came to our country they saw many giant rocks lying about. In New England, especially in the White Mountains of New Hampshire, they found great masses of hard, beautiful stone, shining here and there. These large rocks, or boulders, were of granite, so solid that they could hardly be broken.

Before long men discovered that they could use the granite to make their houses and other buildings. They began to dig into the mountains, and soon there were many quarries in that country. A quarry is a place where stone is cut and taken from the ground.

Ever since the coming of people to the White Mountains, granite has been taken from there. So much has been found in New Hampshire that it is called the Granite State.

Another great granite mountain is Stone Mountain, in Georgia. It looks like a great boulder.

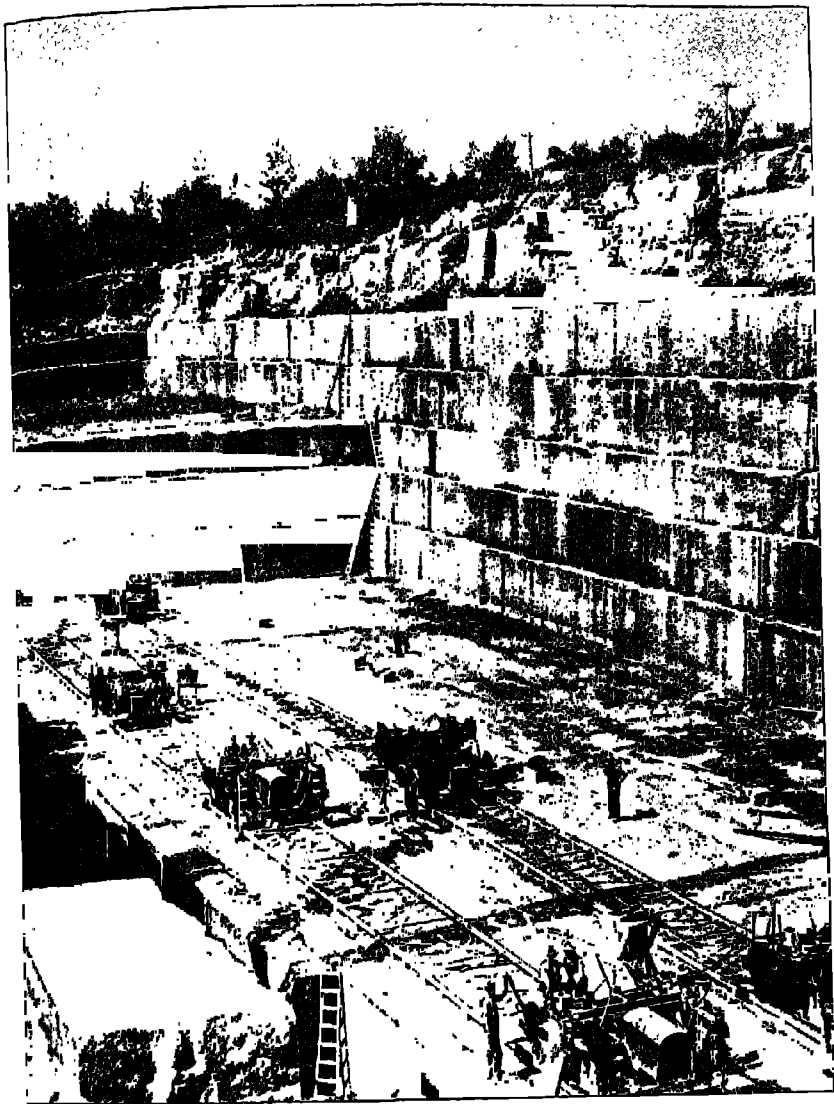


FIG. 45. A quarry where rock is being taken from the ground

There are no trees growing on it, and the storms of many years have made it smooth. Now people are cutting out a story on its surface that will tell about great things that have happened in the past.

There is gold in mountains, too. Gold! What a story of the world and its people the story of gold is! For many thousands of years people have thought more of this shining metal than of all the other things which they own. Do you know the story of King Midas, who loved gold more than anything else on earth? Many people are like Midas. They will leave their homes to go and hunt for it.

And well they might think it beautiful, for gold always remains bright. Rings and pins made of gold never lose their shine.

In the early days of our own country, less than a hundred years ago, someone discovered gold in the mountains of California. No sooner was it found than thousands of people sold their houses, their farms, their furniture, everything they owned, and set out to find the gold. Many of them died on the way. But people still rushed to get to California, and since then we have called that time the "gold rush."



Erving Galloway

FIG. 46. This is the way gold was mined in California. The gold was near the surface of the earth

In those early days gold could be found on the surface of the mountains. It would be hidden in the gravel in the bottom of a river or a stream. The gold-miners needed only to get it away from the gravel. They would place the gravel in a pan and shake the pan back and forth in the running water in the stream. The gold was much heavier than the gravel. The water would wash away the gravel, and after a while only the gold was left in the bottom of the pan.

When the gold on the surface was all gone, they began to dig down deep into the ground for more. Later, with bigger and bigger machines the miners dug into the mountain sides. Deeper and deeper they went, always hunting for gold. Sometimes they dug and dug, all for nothing, and died poor men.


But there are even more important things than gold that men have found by digging into the mountains. Later you will read the story of iron in the mountains. We could not have many of the things we use today if the iron had not been dug out of the ground. Each continent has some.

Later too you will hear the story of the coal in

mountains. Can you think of how our engines would be run if we had no coal? You will find that every continent has mountains in which coal can be found.

You will also read of copper and tin in the mountains. Indeed, one of the most important things men do in these days is to dig in the mountains for all these things.

Do you see now how very important mountains are to men? Of course we have studied only a few things about them. Later we shall study more.



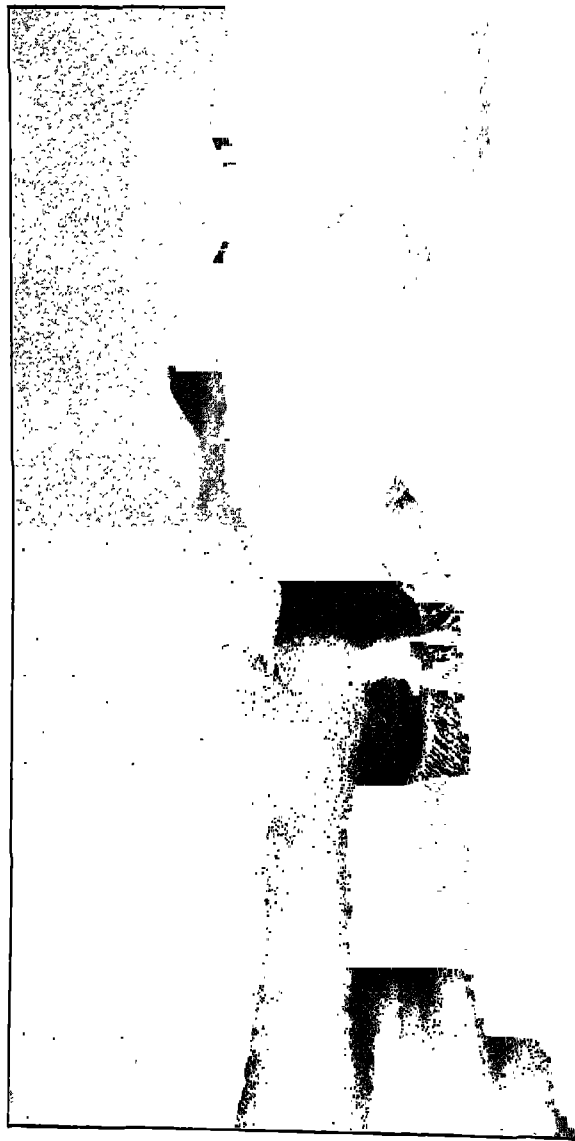


FIG. 47. Java has three big volcanoes in a group. Can you see why they might be called fire pots of the world?

CHAPTER IX

Volcanoes, the Fire Pots of the World

YOU REMEMBER that, as the earth cooled, a crust of hard rock formed on the outside. But the inside was still hot melted rock. Sometimes this broke through the crust, and the hot melted material poured out on the surface.

In many parts of the earth today are places where the crust breaks, and out come smoke and gas and cinders and hot melted rock. These pile up higher and higher until they make a new kind of mountain.

Such a mountain is called a volcano.

There are hundreds of volcanoes on the earth. Every continent has some. Some are dead, not burning. Others are alive, burning. Around the entire earth there runs a circle of volcanoes. Look at the pictures of figures 47 and 48. They show what these are. They are mountains on fire inside.

In some places the volcano explodes. Krakatoa did. It blew all to pieces. Krakatoa is a little island near Java, in the Pacific Ocean. For 200 years people had lived on the island near the volcano, and all had been quiet and safe.

Suddenly one night in 1883 gases rushed out of the mountain top, and then the whole top of the island blew off! The crash was heard 150 miles away. Whole miles of rock and dust were thrown high up into the air, higher than any airplane has ever gone. Some of the dust did not come down to earth again for three years.

Explosions went off all night long. Their force shook the earth far away. The waves of the sea were stirred up 100 feet high. They rushed over the land of Java, near by, and killed nearly thirty thousand (30,000) people. The ocean rolled into the giant hole on the top of the mountain and filled it with a lake nearly 1000 feet deep.

How are volcanoes formed? We do not know all about them, but scientists think it happens in the way shown in the picture of figure 48.

Just under the surface of the earth, only a few miles down, is a "pocket," or lake, of hot melted



© Scientific American

FIG. 48. A few miles down in the earth is the hot melted rock called lava. When the crust breaks, the lava comes through the cracks and flows out on the earth. This forms a volcano. (After a drawing by C. McKnight Smith)

rock called lava. When the crust of the earth moves, huge cracks are made in the rocks. Some of this hot lava rises up through the cracks inside the mountain and flows out of the tops. Higher and higher it piles, until it forms a volcano.

The top, or mouth, of this volcano is called the crater. A good picture of the crater of a dead volcano is shown on page 125.

Here is the story of the way in which one volcano became alive:

One day clouds of smoke filled the crater of the volcano. Higher and higher they rose until they hid the sun. Everything around was covered with a black cloud.

Then the earth began to shake. Loud sounds seemed to come from the inside. Louder and louder they grew until they seemed like thunder coming nearer and nearer.

Suddenly flames burst from the crater and shot up into the air. The clouds became very red, and the whole sky seemed to be on fire. Millions of sparks flew upward and fell again like a rain of fire on the sides of the mountain.

Meanwhile there rose from the volcano's chimney



© Aerial Explorations, Inc.

FIG. 49. Looking down into the crater of a dead volcano

a river of melted material — a river of lava. This filled the floor of the crater until there was a lake of fire as bright as the sun. Loud noises continued to come from the inside.

Soon the crater was full. Then the volcano shook. The sides of the crater split open, and over the edges and through the cracks rushed the rivers of lava.

Down the mountain they ran, destroying everything in their paths. Trees burned for a moment and then fell to the earth. Houses were ground to dust, and the hardest rocks were broken and melted.

Then the lava stopped flowing, and the gases began to come out of the volcano, bringing with them ashes and cinders. For miles around they filled the air and settled on the earth.

At last the terrible mountain was quiet, and everything went on as before.¹

Today, in many parts of the world, there are volcanoes that have been quiet for a long time. We say that they are dead. Water fills the hole of the crater. Grass begins to grow at the foot of the

¹ This story is adapted from Fabre's *This Earth of Ours*, pp. 117-120. D. Appleton-Century Co., New York, 1923.



United States Army Air Corps

FIG. 50. The black spot shows the hot lava pouring down the mountain. Can you imagine what it will do to the little town?

volcano. People come near by to live. They build their houses and villages, and life goes on.

How Volcanoes Destroy Cities

Such a quiet volcano was Mount Vesuvius, in Italy. For hundreds, perhaps thousands of years, it was silent. People lived in their cities near by. Then one day the volcano began to smoke. Clouds of ashes rose from the crater. Lava began to pour from the sides.

Three cities that lay at the foot of the volcano were buried. For fifteen miles around, everything was destroyed. Lava covered the streets. It covered the houses. It covered the land and the people. Some day you can read the story in a book called *The Last Days of Pompeii*.

How a Volcano Island Was Made

At some spots on the earth volcanoes suddenly appear. About 100 years ago a ship was passing the island of Sicily, near Italy. All at once the captain of the ship saw that about 30 miles away the sea was boiling. He went near the place. He saw dead fish coming to the surface of the water.



© K.N.I.L.M.

FIG. 51. This shows how a new island was made from a volcano
that rose from the sea

A stream of water shot into the air and fell again upon the sea.

When the ship reached land, the news spread quickly: "A new volcano is coming up through the sea!" The people on the shore watched it rise higher and higher as it threw out its dust and ashes.

Soon they could see smoke rising from the water. At night the smoke was lighted with flashes of fire. A noise like thunder seemed to rise from the sea.

A few weeks later the captain found a small island near the spot where he had been before. An island had been born out of the volcano. In the center was a crater. Reddish water was boiling in the crater, and smoke and gases rose from the water. All around were volcano ashes and dead fish. Two weeks later a scientist visited the new island. The pictures in figure 51 show how it was made.

So there are many kinds of volcanoes, as the pictures show us. Some, like Mount Vesuvius in Italy, are single cones out of which come the gases and the hot melted rock. In others, like Mount Etna on the island of Sicily, there are many little cones, each one throwing out hot rock. Still others, like Mount Fujiyama, are dead volcanoes.

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In some parts of the earth there are many volcanoes close together, with smoke and lava coming out of the earth at hundreds of places. In Alaska there are 60 volcanoes together.

From all this you can see that volcanoes change the earth's face in many ways. They pour out huge lakes of lava, too, which pile up into flat, rocky land. In our own country there is one of these flat lava lands 3000 feet thick. In India there is one a mile thick. All over the earth there are hills that were formed from lava that long, long ago poured out of some volcano.

Geysers : Hot-Water Fountains

Not only do rock and gases burst from the earth. In some parts of the world hot water rises into the air in much the same way as the lava does. When a stream of water rises from the inside of the earth, it is called a geyser.

The picture of figure 52 shows a geyser in Yellowstone National Park, in our own country. There are other geysers in Iceland and in some of the islands of the Pacific.

Geysers are not busy all the time. "Old Faithful,"

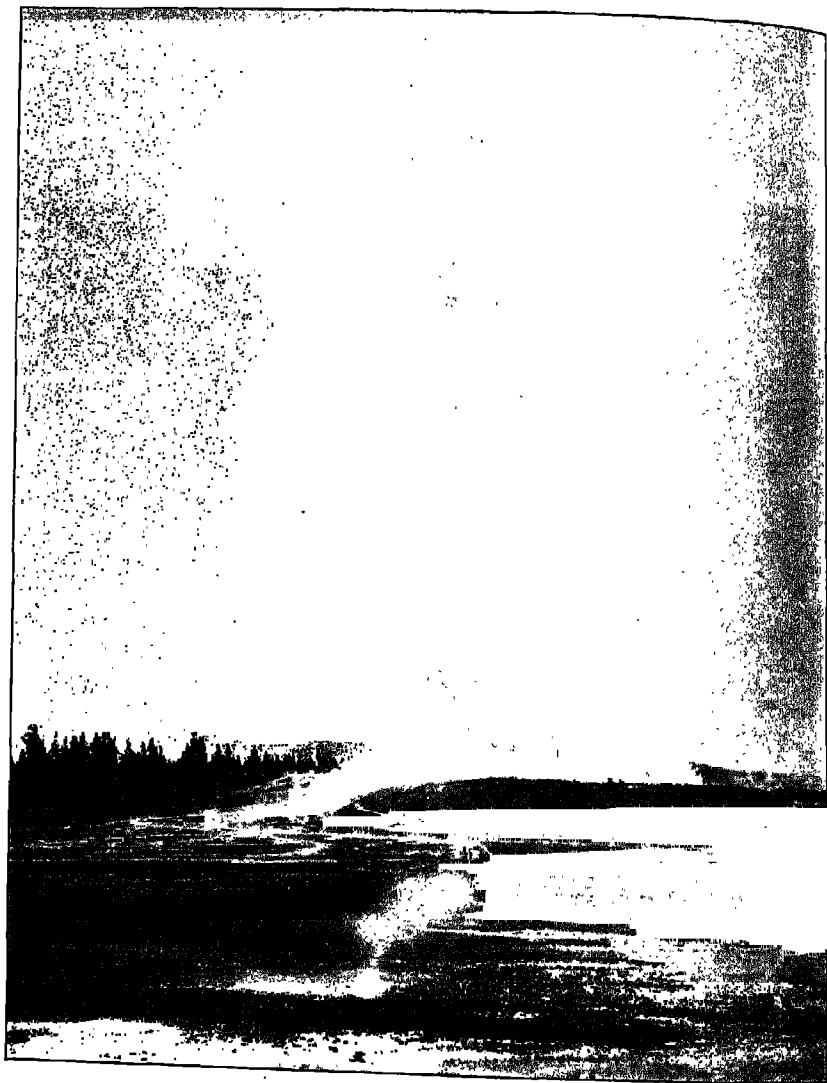


FIG. 52. One of the geysers in Yellowstone National Park. A giant stream of hot water is rising from the inside of the earth

a geyser in Yellowstone National Park, spouts up every 65 minutes, day in and day out, as regular as the bell on a clock. Each time it starts the same way. The waters around the hole tremble. Then they rise perhaps 15 or 20 feet. Up and down they go, each time higher and higher. Then, suddenly, out of the geyser hole comes a giant stream of white water climbing up and up to 150 feet before it falls back splashing into the pool around it. A few minutes it "plays." Then it drops down lower and lower and is quiet again for another hour.

A most surprising thing! What makes it happen? Once again we do not know exactly. It is thought that below the surface of the earth the rocks have not cooled off. At the top the earth cracks, and the water runs down into the cracks. This water turns to steam and comes spouting out of the cracks in the earth as a geyser.

CHAPTER X

How the Earth Got Its Skin

PERHAPS YOU are thinking that the earth as you know it is not all rock. It is soil and grass and trees and bushes. In many places, indeed, most of the rock is covered up. If you live on a farm in one part of our country, you may see almost no rocks. Everywhere is black soil. But if you live on a farm in another part, you will see much gravel and many small stones. The fields are covered with large rocks too, and the soil is very sandy and stony.

So you see that our story of the earth must have another chapter. That chapter tells how the great, rocky earth got a thin covering—a kind of “skin.” It is a skin of clay and sand and gravel. How important do you think that skin is?

It is in soil that the farmers raise the corn and wheat, the potatoes and other vegetables, which we eat as food. It is in soil that cotton grows—the cotton which is used in making clothes.



FIG. 53. The Grand Canyon of the Colorado. Water, wind, and dust have worn away the rocks until the river flows through a deep, deep cut. Do you see how tiny the man on the edge seems?

It is clay that is made into bricks, out of which buildings are made. It is gravel and sand that are used to make roads and dams and bridges.

How did the rocky crust of the earth become the clay and sand and gravel that we see everywhere today?

Here is the story:

How the Earth's Rocky Crust Formed into a Thin Skin of Soil

In the first place, there were three things that were hard at work to change the rock. One of these was water. No sooner were the mountains and hills lifted up high than water began to wear them down. It rained and rained and rained. Day after day the water fell on the mountains and ran down the sides into the valleys.

Perhaps you wonder how water could wear away mountains. On the next rainy day go out and watch what the running water does to the gravel roads and paths around your home. Even the tiny streams wear little tracks in the sand and gravel. If the rain comes down harder, each little stream becomes bigger. It runs along, always hunting a way downhill



© Fairchild Aerial Surveys, Inc.

FIG. 54. The water of Niagara Falls is wearing away the rocks as it rushes over them

and carrying tiny stones and sand and gravel with it as it goes.

Other little brooks and streams join in the big stream. After a while the stream joins a small brook. Broader and broader, deeper and deeper, it becomes. Follow it along. Now there is more force to the stream. It carries along not only soil and gravel but rocks and stones as well.

Here and there it moves over small rocks. Although you cannot see it at work, the water very, very slowly wears away the rock. Every movement of one rock upon another rubs off some of the surface. Rub two rocks together with your hands and notice the tiny bits that come off.

After a while, if the rocks are soft, the water will wear large cracks in them. Pieces will break off, and these will move on down the mountain with the stream.

If the rocks are hard, like granite, they will not be worn away, but the soft rocks around them will be. That has happened in such places as are shown in the picture of figure 53.

Niagara Falls (figure 54) was made in this way. It was made by the Niagara River. For thousands



George R. King

FIG. 55. For millions of years the water has fallen down the mountains, breaking off rocks, widening the cracks, and making deep cuts in the valleys

and thousands of years that great river has slowly worn away the rocks below. On the one side, where the water rushes strongly, it eats away the giant wall of rock about five feet each year. On the other side, where the water moves with less force, it cuts away the rock only a few inches each year. Think what the falls will look like in a hundred years!

The picture of figure 55 also shows how water wears away the rocks.

For more years than anyone knows about, all over the earth, streams and brooks and rivers, small and large, have been eating into the earth's surface. Down the water has come, making the sharp mountains smooth, breaking off rocks, widening cracks, and filling up the hollows with soil.

But water is not the only thing that helps to wear away the earth's surface. Air and wind are also at work all the time. Wind is really moving air. Look out of the window on a windy day and see the tricks that the wind is playing upon people. It blows off their hats and rolls them down the street. It turns umbrellas inside out, blows the rain through open windows, and bangs the doors. Figure 56 shows what wind can do to rocks.



N. H. Darton

FIG. 56. What do you think is a good name for this mountain in western Nebraska? Wind and weather have made it this queer shape

The wind plays tricks on the rocks, too. It rolls them about, and, as they roll along, small bits are broken off or rubbed away.

Through all these millions of years the wind has helped in other ways too. In the air there are tiny bits of dust. Look through a ray of sunshine as it falls through the window into a room and you will see the dust moving in the air. Now, although we cannot see it happen, the wind is blowing these bits of dust against the earth all the time. The dust makes the rocks slowly change.

Heat and cold also work quietly to make our earth change in many ways. During hot days the rocks become larger. In the cold seasons they become smaller again. When they become smaller they begin to crack; and when the waters come rushing along in the spring, it is easy for them to get into these cracks and so break the rocks up into many smaller pieces.

So it was that over the entire earth this wearing away of the rocks by water and cold and heat and air and wind went on year after year. After no one knows how long they broke the rocky crust of the earth into smaller and smaller pieces.



G. K. Gilbert

FIG. 57. Heat and cold have helped to break and crack these rocks

Some of the pieces were still fairly large, and we call them boulders. Others had been broken into even smaller pieces. We call these gravel. Other pieces had been ground even finer. They are called sand. Finest of all are the tiny bits that we call dust.

In many places the bits of dust mixed with water and became mud or clay. Along the banks of the streams this mud or clay was left. Some of it dried and was blown by the wind out over the flat lands. So it was that the earth got its "skin."

Here and there, all over the earth's surface, in place of solid rock, there came a covering of large rocks and soils of different kinds. The soils are made up of sand, gravel, mud, clay, and other kinds of earth covering that we know today.

How thick is this covering? If you should dig down somewhere near your home, how far down would you have to go in order to "strike rock"? In some places not very far, for the soil over the rock is only one or two inches thick. In other places it is hundreds of feet thick. But even where it is thickest, it is only a thin skin on a thick, rocky earth.

It is, indeed, like the skin of an apple or an orange.

CHAPTER XI

The Earth Was Ready for Life

Life!

EVERYTHING WAS ready for life. The crust of the earth had formed. The oceans and seas and bays were there. Soil had been made from the rocks. A thick blanket of air lay around the earth, and light and heat were coming from the sun. It was not too hot and not too cold, and everything was ready for living things.

And then, after millions and millions of years, life came on the earth. Living things appeared.

What do we mean by living things? Do we mean stones? or houses? or books? No, not any of those things.

A tree is a living thing. It is born from a seed. It grows bigger and bigger. It changes and changes until it gets old. At last it dies.

Horses and cats and dogs are living things. First they are young and small. They grow and change.

Then they become full-grown. At last they grow old and become weak. Then they die.

People are living things. They are born as babies. They grow, becoming children, then young people, then grown-ups. At last they too grow old and die.

This is the story of all living things. First they are young and tiny. They grow and become strong. They grow old and become weak. Then they die. That is the story of all animals and all plants.

The First Living Things

We do not know what were the first living things. We do not know how life began. But the story of life begins with a very simple kind of living things. These are so small that no one can see them with his own eyes.

What these tiny living things were we do not know. We think that they were like the tiniest living things which we know today.

In all the oceans and seas of the earth we find billions and billions of these tiny living things. They are everywhere — in the air, in the water, in plants, in our own bodies. You cannot see them, but there they are.

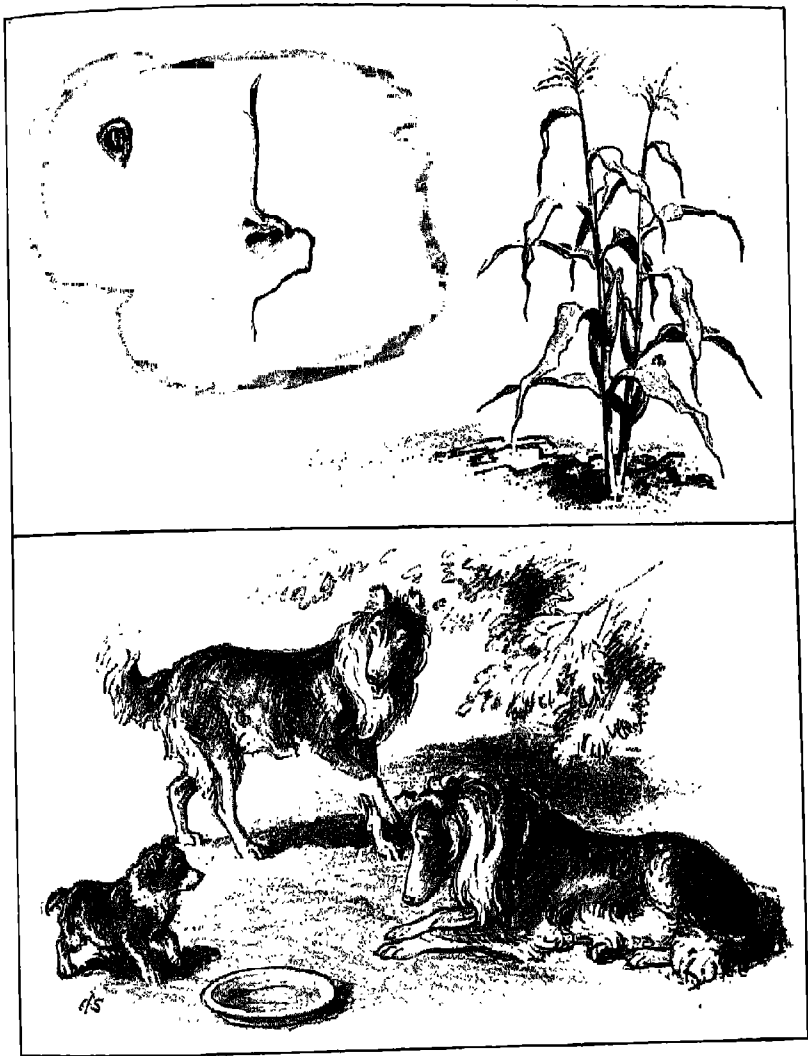


FIG. 58. The story of living things. First they are young and tiny. They grow and become strong. They grow old and become weak. Then they die

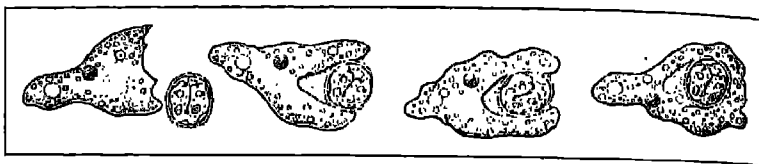


FIG. 59. The cell taking in food and growing

These tiny living things today are called cells.

Being a living thing, a cell can do all that a living thing can do. It can take in food.

The cell can grow, too. As it takes in food, it changes the food into part of the cell.

But the cell can do an even more wonderful thing. Not only can it eat and grow; it can divide into two cells. The drawings show you how that happens.

Do you see how many cells come from one single cell by dividing? Each cell divides into two parts, making two cells. Each one of the cells eats and grows and then divides into two more cells. That makes four. Then each one of the four divides into two cells. That makes eight. Again each of them divides, and there are sixteen cells.

Can you go on and show how many cells are made as each cell divides into two parts? You

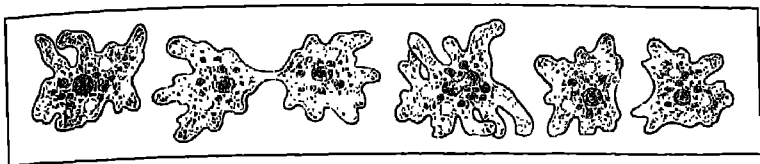


FIG. 60. The cell dividing into two cells

would have to put millions of cells together before you would have one small mass of cells that you could see. One kind of cell is so small that you could put 12,000 of them on a line one inch long. This line is an inch long: _____.

The Cells Changed

Many, many years passed. The sun's rays fell on the waters of the ocean. They fell on the land too. They helped the tiny living things to grow. The living things found food in the water and the air. They grew and grew and divided and divided.

Then they began to change. Sometimes the water would dry up in the places where they lived. Millions of them died. Most of them could not live without water. But others sent out little feelers and caught on to the edge of the land. They were able to go on living. They changed in many ways.

Many more millions of years passed. The tiny living things began to change and grow. As they changed and grew they joined other cells that were changing and growing. They became larger and joined other kinds of living things.

We think today that the story of the cells is the story of all life. All life seems to come from living things. These grow and change until they become old and die. But before they die they make other living things. These grow and change until they too become old and die. And so the story goes on.

The Story of Life Goes On

For billions of years the cells grew and changed, grew and changed. Then some of them became plants. Others became animals. In the beginning it was hard to tell which were the plants and which were the animals. But, as time passed, it became more and more clear, because they changed in so many different ways and began to look different from each other. Even today, however, some people find it hard to tell some plants from animals.

But all the living things on the earth are either plants or animals.



FIG. 61. A seabeach many millions of years ago. The animals and plants are in and near the water

The World's Garden Today

How many plants that are living on the earth today do you know? Do you know ten? How many different ones does your class know? Twenty? Most of us know only a few — perhaps a hundred at the most.

But scientists have found and given names to 200,000 kinds of plants! Can you imagine so many different kinds? Look through a book about plants and you will see how many there are. We cannot picture many of them in this book, but on page 153 we give a few of those on the earth today.

How many kinds of plants do you think there were long ago? No one knows how many grew and lived and died while the earth was forming. Certainly it must have been a huge number.

The Wonder and Beauty of Plants

Of course it is interesting to know many different kinds of plants; but even if you know only a few, you can understand how beautiful they are. Can you remember all the colors in a garden of

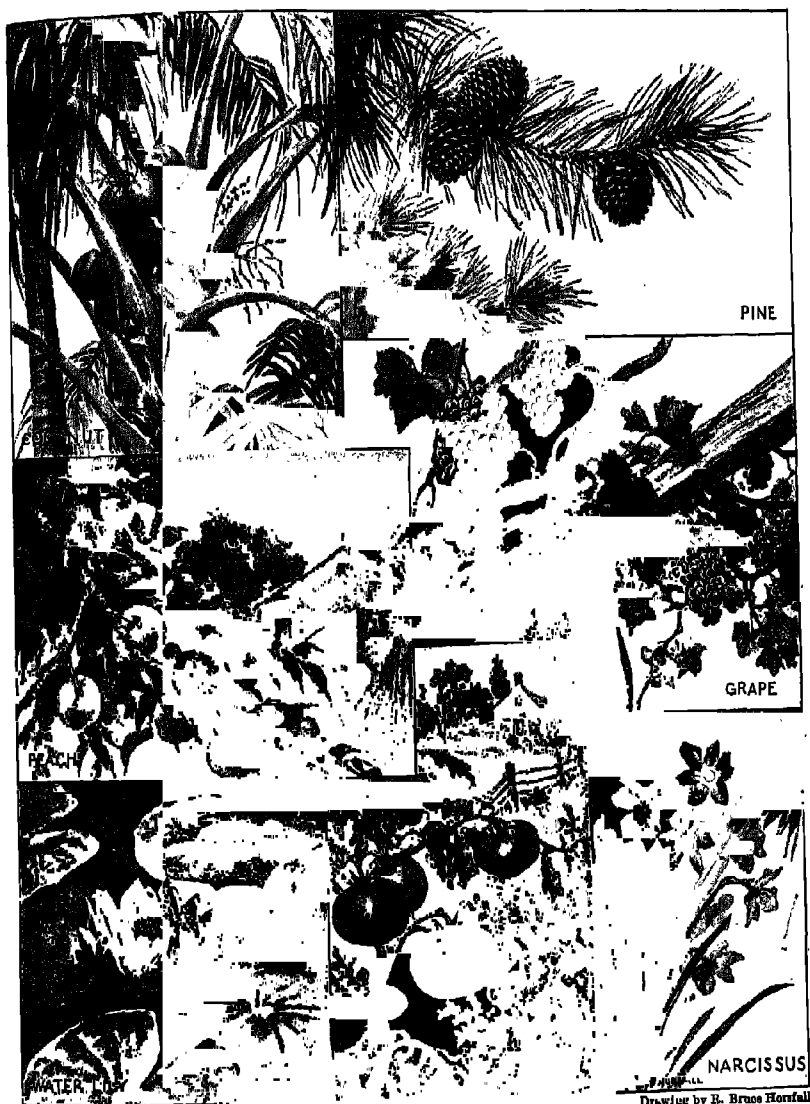


FIG. 62. These are only a few of the many kinds of plants living today

flowers in the summer? Have you ever smelled the blossoms on an apple tree in the springtime?

The earth is a beautiful place because of the plants. Without them it would be dull and bare.

Plants Live Only in Certain Places on the Earth

Of course there are not 200,000 kinds of plants near your home. Not even in our own country, nor even on our whole continent, are there that many. That is the whole number that have been found and named on the entire earth.

In some places there are no plants at all. On rocky mountains there are few plants. On dry sandy places there are very few plants.

You know why plants do not grow in such places. They must have soil in which to grow. The atmosphere must not be too hot. It must not be too cold. It must not be too dry. But on most rocks there is no soil. In sandy places it is too dry.

There are many places where plants grow well. The soil is good; it rains enough of the time; it is warm or it is cool. So plants—many kinds of plants—grow there. Later you will hear about the places.

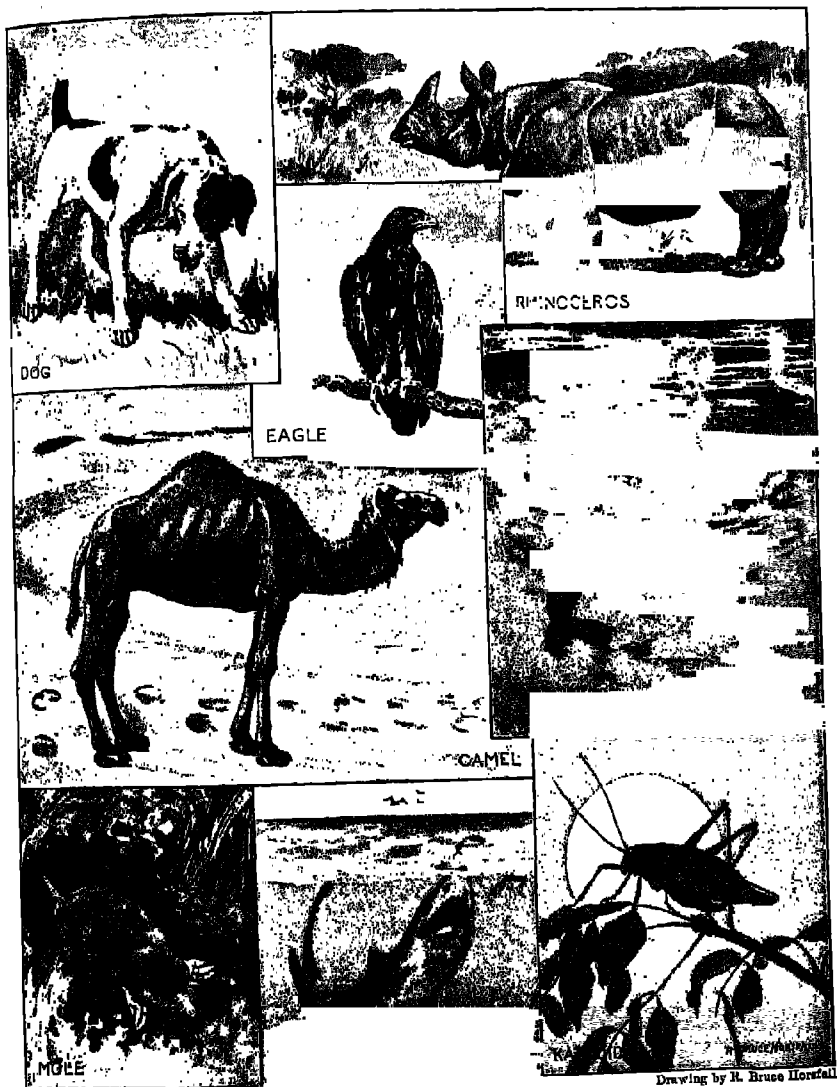


FIG. 63. These are just a few of the many kinds of animals living on the earth today

The World's Zoo Today

You can easily remember one thing: where plants grow well, there you are likely to find animals and people living. Why is that true? Because animals and people live partly by eating the plants.

On pages 155 and 157 are pictures of a few of the kinds of animals living on the earth today. How many of these do you know?

How many different ones are known by all the members of your class? Write the names of all the kinds the class knows.

These are all "animals." Sponges are animals. Worms and insects are animals. Fish are animals. Snakes and lizards and frogs are animals. Cows and horses, dogs and cats, monkeys and *men*,—all are animals.

What differences there are among animals! An earthworm and an ant and a man! Is it strange to think of them all as animals?

The animals in the pictures are only a tiny number of all the different kinds of animals living today on all the continents.

Scientists have found and named more than



FIG. 64. All these animals belong to the cat family

815,000 different kinds of animals living today. Some are on the high flat lands of far-off Asia; others are in the jungles of Africa. Some are in the icy waters near the poles. Others travel on the hot sandy land of Africa. There are many hundreds of different kinds on the whole earth! We can hardly imagine so many.

Of course only a few live near your home. In some places there are almost no living animals. But in other places, such as the oceans and seas and lakes and rivers, there are great numbers of animals. There are too many to count.

Animals cannot make their own food, so they live only in places where there are plants or other animals which they can eat for food.

Go to the museum in the city nearest your home or look through books about animals. There you will see what many hundreds of strange animals are like. But even after you have seen these many hundreds of animals, you will not know even a small number of all the different kinds of animals on the earth today.

How very hard it would be, then, to imagine all the many kinds of animals that must have lived

and died in the ages of long ago! For animals were born and grew and changed and died through the long life of the earth, just as plants did.

As we said about plants, however, you may know only a few animals and understand how important they are to men. Some of them do the work of men, pulling and carrying heavy loads. Others provide us with fur and skins to make into shoes, coats, and other kinds of clothing. In some places, without animals, people would die. The ones that can be tamed easily are our pets.

So, in many ways, the great number of animals on the earth are very useful to people.

CHAPTER XII

How Do We Know the Story of Plants and Animals?

The Death Trap of Long Ago

A FEW YEARS ago a farmer in California discovered that he had a small lake of tar on his farm. "This tar will make good roads," thought the farmer to himself. "I can sell that."

So he put some men to work to dig it up. As they dug they began to find the bones of animals. Soon they had a large number. The farther they dug, the more bones they found. At last there were so many that the tar could not be used for road-making.

Some scientists who study about the rocks and the soil of the earth heard about these bones. They went to California to learn more about them. Very carefully they picked up those that had been found. Then they began to dig for more.



F. M. N. H.

FIG. 65. Scientists think that some of the animals whose bones were found in the tar pits of California looked like this

Day after day new bones were added to their "dead zoo." Whole animals were lying carefully held in the tar lake, — wolves, lions, tigers, eagles, foxes, bears, horses, rabbits. There were thousands of bones of animals. What a zoo it was!

Many, many years before this time these animals had stepped into this lake of tar and had been swallowed up. There they had died, and through the ages the tar had held on to their skeletons. Then, by an accident, they were discovered. Scientists are now using them to learn about living things that were on the earth long, long ago. Do you wonder that this tar lake was called "the death trap of long ago"?

There have been many other traps in which plants and animals of long, long ago were buried and kept whole. Deep down in oceans and seas fishes have been caught and covered up by mud and rock. In the cold ice of the land near the north pole huge animals have been swallowed up and their bodies kept in the ice. Then years later in our own day they were found by men.

In hot places insects have been caught in the running sap of trees. The sap has hardened, and



State Museum of Illinois

FIG. 66. Digging in the earth in Illinois for fossils

has held the insects' bodies there for long, long ages. Today they are also being discovered by scientists.

An Elephant Hunt in Illinois

On a warm January day a few years ago some workmen in the southern part of Illinois were digging in the earth. A dam was to be built across the river, and they were getting the ground ready. With a strong steam shovel they were digging great chunks of earth out of the ground.



State Museum of Illinois

FIG. 67. An elephant's tusk which was found

Suddenly the machine broke. Workmen gathered around to mend it. While one of the workmen was looking down he saw something white shining in the ground. He pulled at it. Out came a giant tooth! It was not a man's tooth; it was much too large for that. It couldn't even be a horse's tooth. What animal could have chewed its food with that tooth? Surely it must be a giant monster of long ago.

The exciting news spread around the town. People came to watch and to help dig. Quickly



Painting by Charles E. Knight

FIG. 68. The mammoth whose tusk was found looked like this

and carefully they dug out the bones. Soon someone pulled out a tusk that was eight feet long and seven inches thick.

An elephant! In the United States, of all places! We thought that elephants were found only in Africa and Asia! But there it was — an elephant's tusk, buried ten feet deep in the ground.

A scientist came and took charge. Very carefully the workmen dug out the scattered bones of the great animal. Many of them were decayed and fell apart. So the workmen put something around them that would hold them together. Very gently they brushed off the many little pieces.

Piece by piece they dug out the bones of the giant. Piece by piece they put them together again. At last the great skeleton was finished. The whole animal was there. It looked much like an elephant, but it was a little different. It was a "mammoth," an animal of the same family as our elephants of today. These mammoths lived their lives and died many millions of years ago on the land where our country is now. How they died we do not know. We know only that they are all gone. On no continent can they be found alive today.

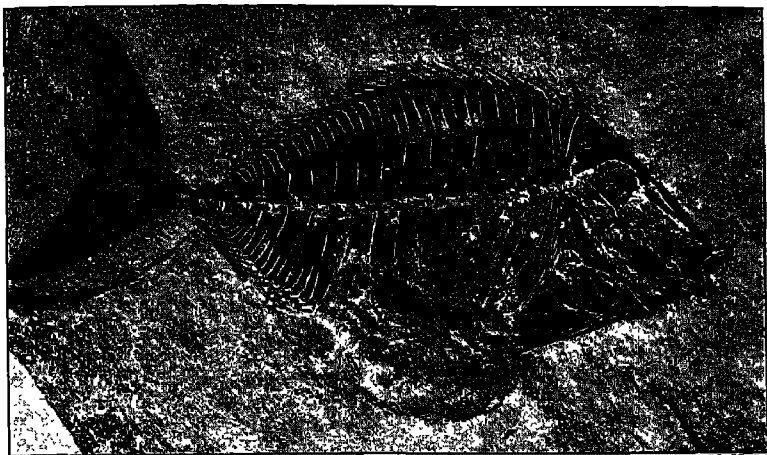


FIG. 69. A fossil of a fish

A. M. N. H.

Fossils Tell the Story of Plants and Animals of Long Ago

Those plants and animals that we find held together in the earth are called fossils. Everywhere on the earth they have been found. Layer after layer of rock and soil holds them. These layers are really the chapters in the "Story of the Rocks." By studying them scientists have put together the whole history of how plants and animals grew on the earth.

The top layers tell the last pages of the story of the past hundred million years or so. But the very lowest layers tell us of what happened a billion years ago.



FIG. 70. A fossil of ferns

Below these layers are rocks where there are no fossils of plants or animals. The bottom of the Grand Canyon of the Colorado River (see figure 53) is one of these. It is a mile deep. In this layer we can see today some of the very oldest rocks that were ever on the earth. No fossils are to be found there.

How Old Are the Fossils?

Many times we have said thousands and millions and billions. Can you imagine so many years? Nobody can really imagine so long ago, but we do know that it is a very, very long time.

We must go to the scientists who study the rocks and the soil if we wish to know how old the earth is and how long it took the fossils to form. These scientists can answer our questions. They have a way of showing how many years passed while the top layer of rock and soil and gravel was forming. They tell us that the giant folds in the mountains came at least several hundred million years ago. That is longer than you can think of.

They have made a kind of clock which tells the time of the earth's history. Not in hours does it measure, but in *eras*. An era is a very, very long time. Scientists say that the longest and oldest eras have lasted more than a hundred million years.

In the oldest mountains the rocky crust of the earth slowly formed. As the hot inside cooled and hardened, the crust was smashed and lifted up into giant sharp mountains. Not just once did this happen, but many, many times. Then the rain and the wind and the water slowly, ever so slowly, wore down these young sharp mountains into old, round, and low ones.

Then perhaps after many more years had passed the crust was pushed in, and the oceans flowed over

parts of the continents. That happened in North America several times. The oceans brought in different kinds of rock and clay and mud and left them on the land. So the kinds of material on the earth's crust became very much mixed up.

Then all would be rather quiet for a very long time. Years and years would pass. Things would begin to grow in the new waters and on the new lands.

Then once more the inside of the earth would burst out again. The crust would be thrown up. The water would rush onto the continents again. The shape of the continents would change. The shape of the oceans would change.

And as the continents and the oceans and the seas changed, the plants and the animals changed. They would be caught in the death trap. Many of them would decay and disappear. But many of them would form fossils.

Now you can see how the story of plants and animals is told by the fossils in the soil of the earth. Fossils can be found almost everywhere. Go out on a fossil hunt some day and see what you can find.

CHAPTER XIII

How Plants Came on the Earth

FROM THE story that the rocks tell about the plants on the earth, would you think that they suddenly came full-grown, as they are today? No, indeed. It took millions of years for living things to grow and become what they are.

You know about the first cells. You know how the sunlight shining down through the waters helped them to grow. After millions of years many of these became the plant cells.

Just how they grew we do not know. Everything seemed to be just right. There was enough sunlight; enough air, enough heat, enough food and water. At first they lived on the bottoms of the seas and oceans.

Then they began to change in many ways. As time passed they were able to live on dry land. Later the cells joined together. They grew bigger and bigger. At last the first plants were living on the earth.

You will see some of these tiny plants if you can go to a pool of water near your home. On the top of the water will be a green scum. This scum is really millions of little green cells hanging together. We believe that these plants are like some of the very first plants of long, long ago.

Some of the plants which came next were the seaweeds. If you have been to the beach you have seen seaweeds. It is believed that they first grew from the scum on the water.

As more years passed, these seaweeds grew and grew. They became larger and larger. Then they too began to change. Slowly stems and branches began to be seen. Veins grew in them through which water and air could pass. Many more parts grew on them, and new kinds were born from old kinds.

Then, suddenly, while these plants were growing and changing, the oceans and continents changed. Water would wash in upon the land, carrying mud and rock with it. The earth's crust would be shaken and folded.

What happened to the seaweeds and other plants then? They were caught in the death trap. Many



© New York State Museum

FIG. 71. Millions of years ago ferns like these began to grow very tall

of them died, and many of them became the fossils which we are finding today.

More millions of years passed. Slowly in the marshes where the lands and the oceans met, and in the low swamps, plants grew again. Then began the fight to live. As the water flowed off the land thousands of kinds of plants died, because they could live only in water. A fish would die if it were taken suddenly out of water. We should die if we were taken out of the air. So some of the plants died.

But as the water left the marshes and seas some of the plants began to have the power of living and growing on land. They could take their food from the wet soil and the air and the sunlight. They grew and grew and made new kinds of plants. Some became tall ferns with great branching stems like those of figure 71. Fossils of these plants have been found.

The growing never stopped. New kinds of plants were always being made as the old plants changed and died. There came a time, nobody knows how many millions of years ago, when many of these plants had changed into trees. They looked like figure 72. Some of these trees grew to be 100 feet high, with trunks three feet across.

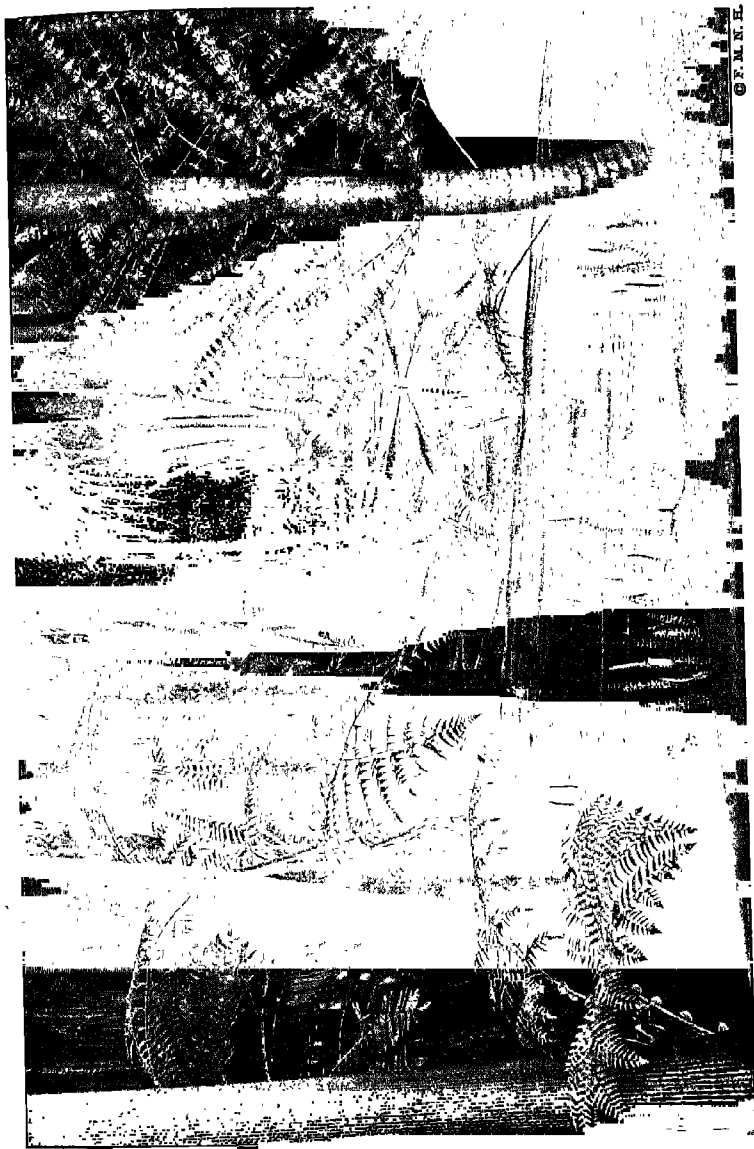


FIG. 72. A forest during the coal age. Many of these plants were later buried and became coal

Plants began to have a new way of making new plants. The trees and other plants made seeds. These seeds fell on the ground and grew into bushes and trees. Each year some of the seeds were carried far and wide by the winds and the rains. You can imagine how many seeds were made by the plants. With these being carried here and there and taking root in the earth, plants began to grow all over the earth.

So it was that slowly the many kinds of trees we know today were born and grew.

After a long, long time flowering plants grew on the earth — roses, lilies, and many others.

Still later, after many more years had passed, plants grew which gave food to men and animals. There were bushes that gave fruit — blackberries, blueberries, and other kinds. There were trees that gave fruit — apples, pears, cherries, plums. Men and animals could eat cereals such as wheat, corn, and oats. There were vegetables, such as potatoes, and plants from which we get tea and coffee.

But these did not grow all at once. Very, very slowly one kind grew from another kind. Millions of years may have passed while some kinds lived



FIG. 73. Throughout the millions of years plants grew and changed

Drawing by Logan W. Reavis

before another kind grew. Thousands of kinds that we do not know of may have lived and died as the earth's crust rose and fell.

Coal Was Formed from the Plants

Thicker and thicker grew the plants. More and more kinds covered the lands. At last much of the earth looked like one of our jungles of today. Figure 72 shows how scientists think it looked.

Then came one of those times when the earth's crust was folded and shaken, making new mountains and breaking down others. The jungles were caught in the trap.

This time fossils were not the only things made. Something else happened. The trees and ferns were packed together. Piles and piles of solid material pushed them down.

All of this changed the leaves and branches and stems of the plants into something new. Today we call this coal. Coal is one of the most useful things on the earth. We burn it in our stoves and furnaces, and with its heat we warm our houses. Coal gives the power to run our engines and machines.

This coal that we now dig from the earth was

made millions of years ago from those early forests that were pushed down into the earth.

All the forests, of course, were not caught and buried. Some of them went on growing and growing. New kinds of plants were born, and their seeds were carried far and wide by the winds and the waves. More new kinds of plants grew on the earth. From them came the plants that we have today. As we said before, there are today more than 200,000 different kinds of plants!

This is a good thing, because without the plants to eat, men and animals could not live.

CHAPTER XIV

The Story of Animals

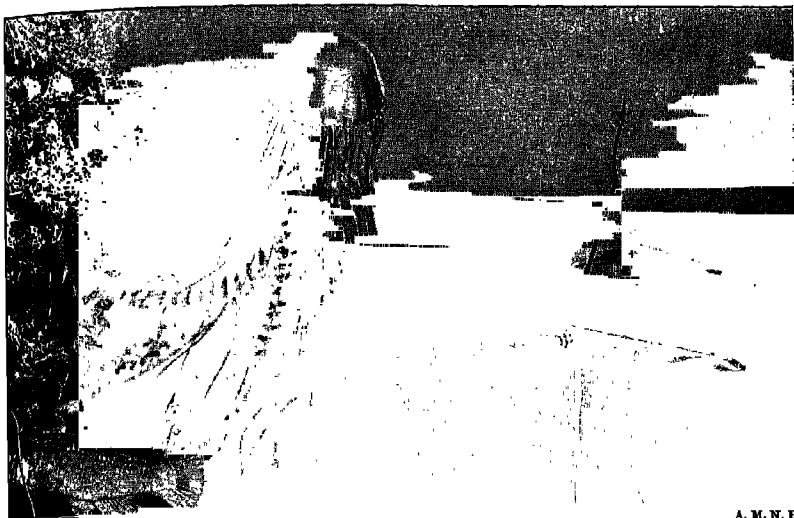
The Story of Animals Is Another Chapter from the Story of the Rocks

LIKE THE plants, the animals did not become alive all at once. They also began as tiny living things. And, like the plants, they grew and changed, grew and changed slowly into new kinds.

One of the first kinds to come were the sponges. Others were jellyfishes and corals. They hardly seem like animals, do they? These animals could not make their own food as plants do, so scientists think they must have come on the earth after the first plants.

We think that the jellyfishes were very much like those which we see today. If you look carefully along the seashore you can find such animals washed in by the water.

When lands and the waters were forming, thousands of other strange little animals formed too. It



A. M. N. H.

FIG. 74. The jellyfish, with its many tails, was among the first animals



New York State Museum

FIG. 75. The trilobite is being eaten by a larger shellfish

is likely that the very first ones had soft bodies. We can see the little marks which they left on the rocks that were folded up by the movements of the earth.

Perhaps some animals came to places where soft bodies were not strong enough. Then animals with hard shells around them were formed. The shells made a kind of armor. "Animals wearing armor!" you say. Yes, that's what they looked like, with a great shell covering part of their body.

The Fight among the Animals

Then the fight among the animals began, in the oceans as well as on the lands.

Of course the strongest beat the others and lived. Those who could swim the fastest or run the fastest, who had strong jaws and other parts with which to fight, were sure to win.

There was a long, long time in which the animals with armor, like the trilobites, won the fight. But after a time still stronger ones were grown. They could swim better and bite better than the trilobites, and their shells were harder.

So these animals, with the help of the first fishes that were beginning to live in the oceans, killed off

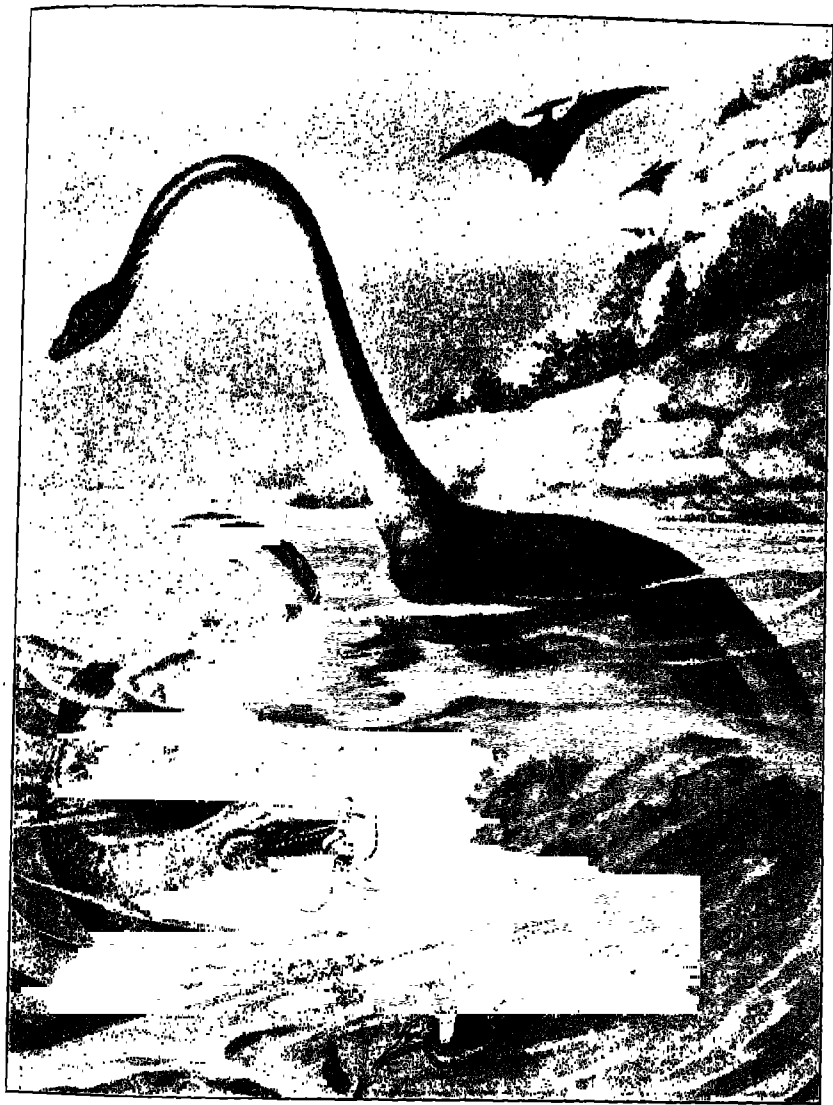


FIG. 76. Queer animals who lived in the sea

the trilobites. For a time these new masters ruled the sea.

But after a while other still more powerful animals grew, and these ruled in their turn.

So time passed. Slowly new kinds of animals came to be. Thousands of kinds of each family began to grow. The shellfish came. New kinds of corals grew. Worms slid along the mud bottoms of the oceans, digging into the ground.

More millions of years passed. Now strange fishes appeared. Some had armor and were good fighters as well. Others had soft bodies and were easily beaten in the battle of living things.

And then came the fish that could walk!

"A fish that walked!" said Nancy, looking at a picture like figure 77. "What a queer animal! Is it a fish?"

"Yes," said Miss Brown. "It is a fish, and yet it is an animal that lives on land too."

"It looks like an alligator," said Tom.

"Yes, it does, a little. Long, long ago some of these animals of the seas learned how to live on land as well as in water," said Miss Brown.

"But how could they do that?" asked Tom.

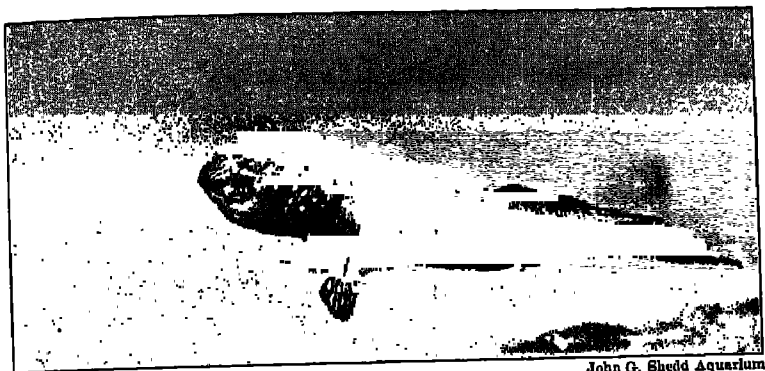


FIG. 77. The fish that walked on land

The Fish that Walked on Land

The fishes that live in the water all the time are made so that they can take the air out of the water. The water goes into their bodies and out, and as it goes through, the air is taken out of it. Fishes breathe air in this way.

Now, if animals are to live on land they must have bodies so made that they can get the air out of all the air around. They must have lungs, so that they can take in air by itself. Dogs, cats, and horses, as well as men, all have lungs.

There came a time when some animals could do two things. They could live in the water part of

the time and could come to the surface of the water and breathe in the air at other times. These early fishes that could breathe the air are called lung-fishes.

Later many kinds of water animals began to come that could breathe in air directly. They began to live on land for part of the time. Snails and crabs were some of these.

Larger fishes began to grow new parts so they could go about on the land. The little fins on which the fishes went about on the land changed slowly into queer kinds of legs.

Later new kinds of animals grew that could live either in the water or on the land. These were called amphibians. You know what an amphibian airplane is. It is one that can rest either on water or on land. Such an airplane gets its name from these animals. The first amphibians were strange animals like those in figure 78. They laid their eggs in the water. The eggs hatched in the water and became living fish, which later walked out on the land to look for food.

There were other interesting changes in these early amphibians. Some were only a few inches



FIG. 78. Another animal that could live both in the water and on the land

long, but others were huge giants of the swamps, and looked like our alligators. They had eyes, as well as noses through which they could breathe.

Many more years passed. Once again the lands were thrown high above the seas, and new animals grew that were strong enough to live in the new world. There were many kinds of these animals. There were turtles and lizards and snakes.

When Giant Reptiles Ruled the Land

Now our story is getting closer and closer to our own day. We reach the time of the reptiles. Of course it is really not close when you think of how many years old you are, but it is close when you think of all the years and years that have passed. Scientists think it might have been a hundred million years ago.

Which "reptiles" do you know? Do you know the little green snakes that crawl through the fields? Or the tiny red lizards that live under stones in your yard? Do you know the black turtle with the hard shell that crawls slowly across the road as you go by in your automobile? Or have you seen the large snakes and alligators that can kill a man?

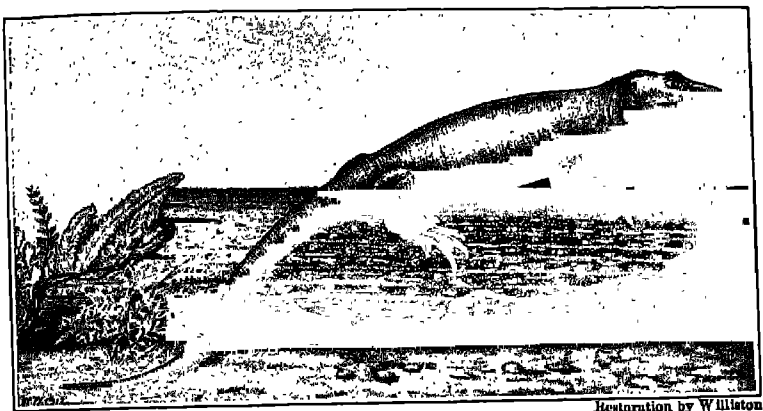


FIG. 79. This may have been the first of all the reptiles

Those are reptiles. But if that's all you know about reptiles "you haven't seen anything yet!"

About two hundred million years ago began the real Age of Reptiles. The Story of the Rocks has given us another chapter which tells of that age. Thousands of fossils of reptiles have been found. They make a strange zoo of long ago.

Scientists think that the first of all the reptiles may have been the one in the picture. His fossil is the oldest one which has been found, and is supposed to be about two hundred million years old. Does he look something like a lizard to you?

Not many thousand years after the time when

he lived, many other strange reptiles began to crawl about in different parts of the earth. There were the kinds with heads like dogs. There were the kinds like frogs and alligators. These lived in the water and ate fish for their food. Some had huge stiff fanlike growths on their backs.

These reptiles were very powerful in their day, and they were the rulers along the beaches of the oceans and the seas. Still others ruled the air. They were giant flying reptiles with wings that measured 20 feet from one tip to the other.

But perhaps the most surprising of all were the real animal kings of the earth years ago. These were the dinosaurs, or "terrible reptiles."

What a zoo of the past is shown in the next pages!

Perhaps you are finding it hard to believe that such animals lived. Are you thinking that these are just paintings and not true pictures of the animal life of long ago?

Most of the paintings were made in the museums of our large cities. The scientists, with the skeletons of these reptiles before them, helped to make the paintings.



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FIG. 80. In the air are some of the reptiles that learned to fly.
Near the ground are the earliest birds



G. P. M. N. E.

FIG. 81. The reptiles with stiff, fanlike growths on their backs



FIG. 82. A giant dinosaur eating a weaker reptile. These reptiles ruled the earth for many, many years

A Fossil Hunt in the Gobi

Here is the story that Dr. Roy Chapman Andrews, one of our country's great scientists, tells of how he found some of the fossils in Asia.

Dr. Andrews set out with his men in automobiles. Up and down hill, over hundreds of miles of grassland and across rough mountains, they went. Then they came to the great, rocky desert known as Gobi. The word *Gobi* means "desert." It is 1000 miles long and 600 miles wide. See if you can find it on your globe.

Day after day the scientists and the men from near-by lands, who were showing the way, traveled across the high land. Day after day they looked across the plain for signs of fossils. Some days they rode over great bare sand hills without water for miles and miles. Then they would go in and out around high rocky cliffs and make their way over rough land.

One day they made camp in a low place near a marsh and started looking for fossils. After a few hours some of the men came running back carrying many small bones. Quickly the whole camp started digging among the rocks and sand for more.



FIG. 83. Fossil of the leg and toes of a great dinosaur

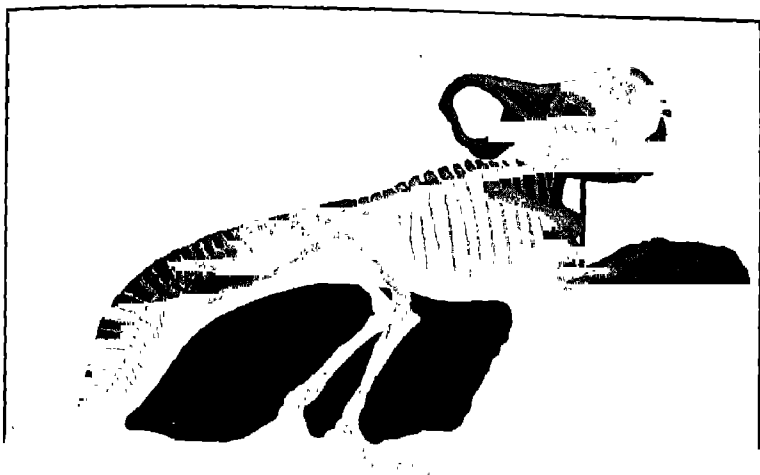
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Suddenly one of the men uncovered a piece of bone. He brushed it off very carefully and soon uncovered more and more of it. When at last all the rock and sand were off, it was found to be more than ten feet long and to have five great toes in place at one end. Here were a leg bone and the toes of a giant animal of the past! What was it?

The scientists came running to see if they could tell. A dinosaur, sure enough! One of the "terrible reptiles." It was the first one found in Asia. They had really found the home of some of the giant animals that had ruled the earth so many hundreds of years ago.

Another day they found a great mass of bones. These were bones of animals 40 feet long. These animals had stood 30 feet high and had eaten off the tops of trees. They had claws and feet like birds. They had short forelegs, so that they ran on their long hind legs like kangaroos.

When Dr. Andrews and his men got these bones back to New York City, they set them up in the museum. The bones, when they were set up, looked like figure 84. Do you see now how sure we can be of these great land and air and sea monsters?



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FIG. 84. The skeleton of a dinosaur found by Dr. Andrews

Monsters they were, some of them standing 80 feet high and weighing 80,000 pounds.

Later you can read the story of the hunt in Dr. Andrews's book *On the Trail of Ancient Man*.

For long, long years these great dinosaurs ruled the earth. There were so many that they were masters over everything. They were kings of the air, of the plains and the mountains, of the forests and the swamps. Everything in the seas feared them.

And then they died. They all disappeared; not all at once, of course, but slowly. After a long time not one was living. Today they are all gone.

What happened nobody knows. Perhaps they were swallowed when the earth moved. Perhaps the seas drowned them, for most of them were not able to live in the water. Or in the beginning the air might have become cold. They needed warmth, and as the air cooled they might have become weaker and weaker.

Then new kinds of animals appeared. They were stronger and could live where it was colder. Perhaps they helped to destroy the reptiles. But a new age was born, the beginning of the one in which we are now living.

CHAPTER XV

Animals Become as They Are Today

WE HAVE seen how the lands and the oceans were made. We have seen how mountains and valleys were formed. We have seen how the soil was made. We have seen how plants and animals grew and changed.

Now we come to the last chapters of the story of our earth.

The Important Things To Remember

The story of our earth has shown us three important things which we should remember.

The first is the long, long time covered by the story. We have had to think back over hundreds and hundreds of years. We must remember that the history of the earth is a very long story. We must learn to think of long, long ago.

The second important thing is that everything grew by slow changes out of something else. Nothing

was made all at once, and nothing came suddenly just as it is today.

The third important thing is that these changes took place time and time again.

We come now to the last chapters of the Story of the Rocks. These tell the story of things that happened only 20 million years ago.

"Only 20 million years ago," you say. "Only a short time!"

Yes, 20 million years are a short, short bit out of the whole history of the earth. Look at these two lines:

This line stands for the last 20 million years: _

This line stands for the whole history of life on the earth: _____

Do you see how short a time the last 20 million years really are?

The Earth Became About As It Is Today

Even if this last period of the earth's history is short, it is very important. It left the earth almost as it is today. It gave us our lands and oceans, the mountains and the plains, the grass and the trees. It gave us the animals almost as they are today.

The New Mountains which Were Made Are Our Mountains of Today

For one thing, about 20 million years ago new mountains were pushed up almost where they are today. Look at the pictures of the Rocky Mountains of North America (figure 41), of the Alps of Europe (figure 43), and of the Himalayas of Asia (figure 42). Their tops reach high up into the clouds.

These are the "new" mountains. They are only 20 million years old! How do we know that they are new? We know because they are so steep and rocky. Not enough time has passed for their tops to be worn away by the rains and the winds. Their rocky sides have not yet been broken up into small bits and washed down into the valleys. So there is very little soil on the sides of these mountains. Only down in the low valleys do you find trees, bushes, and thick grass.

The "old" mountains, of course, have been on the earth for a longer time. They were made more than a 100 million years ago. They are very different from the new mountains.

Look at the picture on page 203. Can you see why the old mountains are different?

The Appalachians of eastern United States are old mountains. They were formed from 50 million to 150 million years ago.

Time has changed them. Notice that they do not have steep, rocky sides like the new mountains. Their tops have been made round by the winds and the rain. There is deep soil on them. Green forests cover them, and bushes and grass grow thick. People can plant crops on them.

Other Animals Took the Place of the Great Reptiles

The giant reptiles disappeared in this new period of the earth's history. *Mammals* took their place. Although they are much smaller than the dinosaurs were, they are the most important animals of today.

The mammals were different from the reptiles in several ways. First, they had coats of hair and fur on their skins. These coats helped to keep them warm so that they could live where it is cold.

Second, most of them walked on four legs. Only a few of them, like whales, swam in the waters of

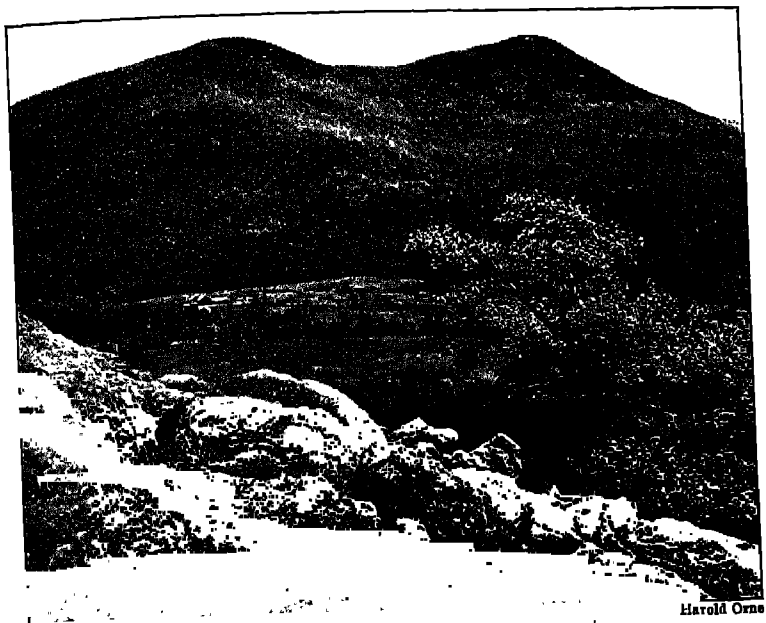


FIG. 85. Green forests grow thick on old mountains

the sea. Look at pictures of the mammals and of the reptiles. See in what ways they are different.

Third, after the babies were born they took milk from their mothers.

Fourth, the baby animals were born alive out of their mothers. This was different from the great reptiles, which were hatched out of eggs.

Fifth, the mammals had warm blood. The rep-

tiles and the fishes had cold blood. The warm blood and the furry coats of the mammals helped them to live where it was cold. Perhaps that was why they could live while the much bigger "terrible reptiles" died out.

The sixth is the biggest difference of all. The mammals had very large brains. They could think better. Although their bodies were smaller than those of dinosaurs, their brains were large.

Just think of the difference between a large dinosaur and a large man. The large dinosaur's body weighed 80,000 pounds, much more than a giant elephant weighs today. His brain weighed about one pound.

A large man weighs about 200 pounds. His brain weighs about four pounds. What a large brain for a little body! The same thing is true of other mammals, such as dogs and cats. They have very small bodies and large brains. They can think better than the reptiles could.

Once more, then, a whole new zoo appeared. In it were some of the early animals, such as the sponges and the fishes. But new kinds of animals appeared as well. Each family of animals grew and

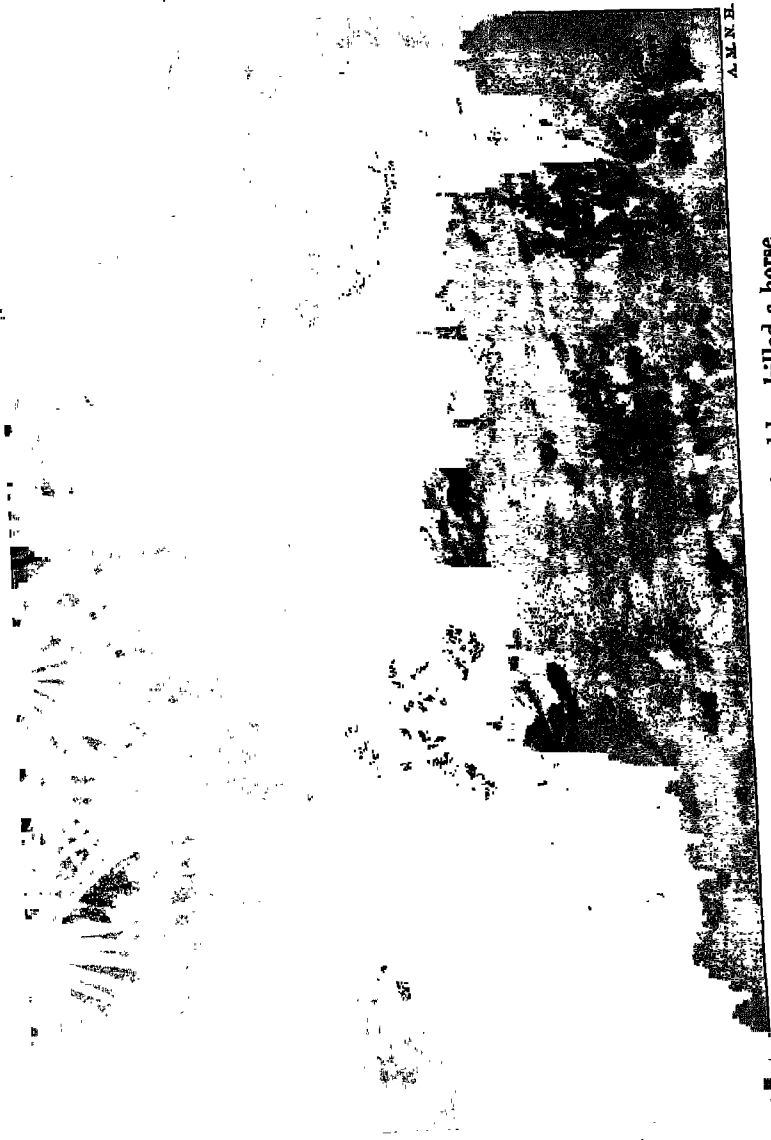


FIG. 86. Early mammals. This big animal has killed a horse

changed. At last animals as we know them today appeared on the earth. The horse came in that way. Let us see how that happened.

From the First Horse to the Horse of Today

Twenty millions of years or so ago there were tiny horses that were only one foot tall and about as large as a large cat. Scientists know this because they have found fossils of them both in North America and in Europe.

After a long, long time new kinds of horses appeared. They were a little taller than the first horse, and their toes had changed. The middle toe was becoming larger, perhaps because they used that toe when they were running. Their teeth were like those of the animals which eat off bushes and trees.

Many more years passed. Then grass began to grow in the plains. The little horses lived more and more out in the flat lands. To eat the grasses there, they began to grow the kind of teeth that were good for eating grass. Their middle toes grew larger so that they could run fast on the open plain.

Bigger and bigger the middle toes became as each new family of the little horses grew up. Longer



G. F. M. N. H.

FIG. 87. Can you name some of these mammals that are living today?

and longer became their legs. After a while the little horses were as large as a tall dog or a sheep today.

Time passed. Some of the kinds of little horses died out. The horses that ate off bushes disappeared. But the runners and the eaters of grass on the open plains lived on.

Taller and taller they became. Each new family grew longer legs. The middle toe on each foot began to look like a hoof, and only two little toes were left, one on each side of the hoof.

At last, we do not know exactly when, horses even larger than ours today lived on the plains. They were five feet tall, with single hoofs. You can imagine how fast they could run. And there were many kinds of them.

This is the way the first little horse became our large horse of today. This is the story which many fossils of the horse — legs, hoofs and toes, teeth, and other parts — have told.

The story tells that as the lands changed and the climate changed and the plant food changed, the horses changed too. They began to grow long legs and hoofs for running and new kinds of teeth for the new food.

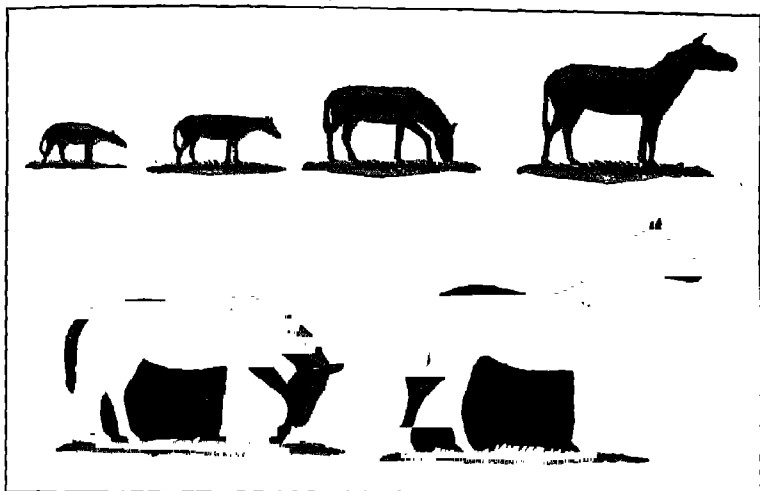


FIG. 88. The story of the horse. See how it has changed through all the years

It tells us too that a very great many years passed while these changes were taking place.

How the Elephant Got His Trunk

The elephant's story tells of another way in which a new kind of animal grew out of an earlier kind. It is the story of "How the Elephant Grew His Trunk." Did you think that the elephant always had his long trunk? No, indeed.

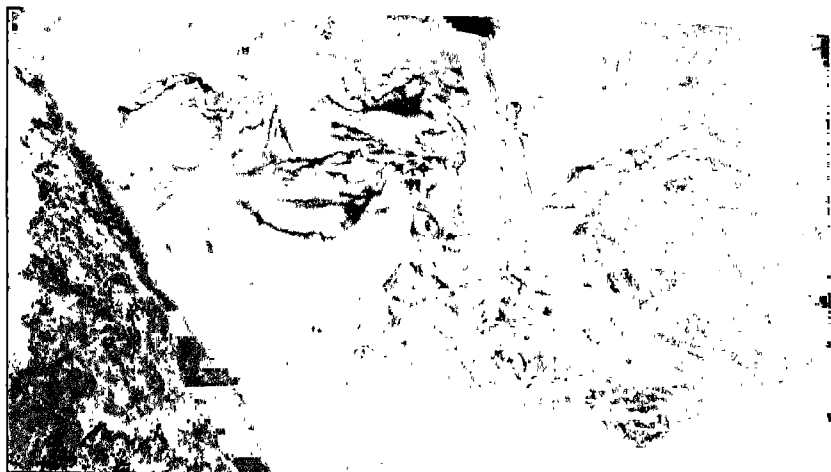


FIG. 89. Finding the bones of an early horse

Bolton Service



FIG. 90. The horse of today draws the bones of the horse of long ago

Bolton Service

Long, long ago elephants were very small, not over three or four feet tall. They had no trunks. They had no tusks. Like the horses, they were great travelers. Over all the continents they went.

As the earth changed and the climate changed and the plants changed, the elephants changed too. As families lived and died the nose and the upper lip of the elephants grew longer and longer. More and more they began to pick up food with this nose and put it into their mouths. Two of the front teeth also grew longer and longer. More and more they became like tusks that could be used in digging.

The whole animal became bigger — head, legs, and body. Finally, after no one knows how many, many years, "the elephant grew his trunk." He grew his tusks. He became as he is today. Look at figure 91. This tells the elephant's story in pictures.

Of course many, many other kinds of animals grew out of earlier kinds in much the same way that horses and elephants did. If our book could be longer, many other stories could be told.

So it was that the earth became as it is today, and the animals that we know today came to live upon it. All of this took a long, long time, much

longer than anything we can imagine. But it is only a small part of the time since living things began to appear on the earth.

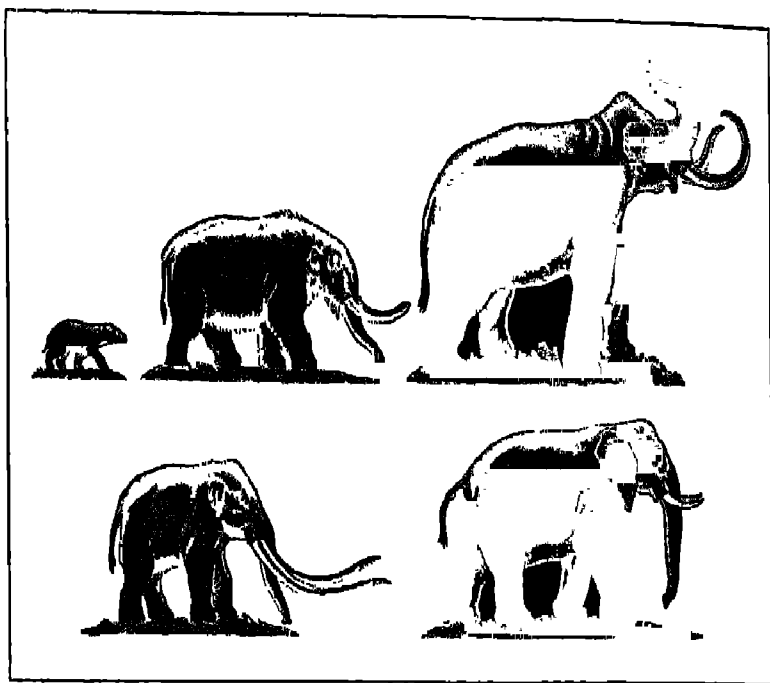


FIG. 91. The elephant has changed in many ways through all these years. In what ways is he different today from long ago?



FIG. 92. How animal life changed

CHAPTER XVI

The Very Early Men of the Earth

THIS IS a story of long ago. It is a story told by a scientist¹ about the first men on the earth.

One Day in Java, Perhaps a Million Years Ago

Two men come running down a forest path. How tall and straight they are! Their beautiful brown-black bodies, partly covered by black hair, shine in the hot sun. Without clothes to get in their way, they move along easily. What runners they are!

Suddenly the leader stops and points to marks on the ground. With great excitement the other crowds close, making movements with his long arms. How strange they sound when they talk! They talk with grunts and queer noises and signs.

¹Professor W. D. Matthew of the University of California. This simplified story was suggested by his account in *Natural History*, Vol. XXVIII, pp. 577-588. With permission of the author and of the American Museum of Natural History.

One of them cries out and points to the thick bushes. A tiger!

The two men bend down. With their long arms and large hands they pick up great stones. Straight at the bushes they throw them. One of them hits the tiger. Out he jumps, angry with pain.

The men stay where they are. They know that they can get away by running up trees near at hand. Soon another shower of stones strikes the tiger. Roaring with anger, he is ready to spring. But suddenly he stops to think it over. Then he decides that the men are too strong for him. He turns around and disappears into the woods.

Down the trail to a big swampy pool the laughing men run. There on the edge lies a giant turtle. What a chance for fun! Picking up some sticks, the men push him off the bank and turn him over and over in the pool.

We cannot be sure, of course, that this story is a correct picture of how the first men looked and what they did. The scientist himself says that. But he also says that there are many reasons for believing that it is nearly correct.

How does he know?

Fossils of Men of Long Ago: a New Chapter in the Story of the Rocks

Once again the fossils tell the story. You have already read about finding the bones of horses, elephants, and other animals. Here and there, over the earth, bones have been uncovered that look like the bones of very early men. Skulls, teeth, leg bones, and other bones have been found in many continents and islands.'

With these bones the tools of early men have also been discovered. The bones and tools tell us many things. They give us one of the most interesting chapters in the Story of the Rocks.

The Piltdown Man

About 20 years ago some workmen near Piltdown, in the south of England, found what they thought was a coconut.

"Let's try to hit it!" said one of them, turning to the others.

So they set it up a few feet away and began to throw stones at it. Soon several shots hit it and broke it into three pieces.



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FIG. 93. The Java men are playing with the turtle

A man who liked to spend his time digging for fossils happened to come by just then and saw what the workmen were doing.



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FIG. 94. This is how scientists think the Piltown man looked

He looked carefully at the coconut and found that it was the skull of a man who must have lived there long, long ago.

"What a wonderful fossil!" said the man. "I must hunt for more." Then he dug in the pit, and soon he discovered other pieces of bone that seemed to belong to the same body.

Later he showed them to a great scientist of England. The scientist went back with him to Piltown, and they did some careful digging. This time they found a jaw which they said was part of the same skeleton.

Most of the bones were missing. But the scientists put the bones of the skull together and fitted in the missing pieces as best they could. From the



FIG. 95. Stone tools like these were found with the fossils of the Piltdown man

skull which they put together they have imagined how this early man looked (figure 94). This man has become known as the "Piltdown man."

When did the Piltdown man live? Scientists do not know about that. Some say half a million years ago. Most of them, however, think it was from one to two million years ago.

Do you wonder how the scientists can tell when these first men lived? They can do so because of the stones, or flints, that were in the same pit as the bones.

You remember that many of the tools of early men have been found. The flints in figure 95 are sharpened stones that



© Illustrated London News

FIG. 96. This is how scientists think the Peking man looked

were used for cutting by the Piltdown man.

You remember also that the layers of rock tell many things to the scientists. When they find flints, they can tell just about when those flints were used. They think, therefore, that the Piltdown man who used the flints shown in figure 95 lived more than a million years ago.

The Java Man

The Java man was living about the same time as the Piltdown man. He is called the Java man because some of his bones were found in the island of Java. Among them were a large piece of skull, some teeth, and a whole leg bone. Though not very

much, these discoveries were enough so that some scientists could write stories about the Java man like the one that you read.

The Peking Man

A few years ago scientists were looking for fossils in China. Near the old city of Peking they found the skull of a very early man. Other scientists came to see it. Most of them thought that it belonged to one of the men of a million or more years ago.

So the fossils tell us of three very early men whose bones have been found in different parts of the earth. These were:

1. The Piltdown man, who lived in England.
2. The Java man, who lived on the island of Java.
3. The Peking man, who lived in China.

On the globe in your classroom find the three places where the fossils were discovered.

These fossils tell the story that the first early men have lived in nearly all the continents. In our own North America and in South America, however, no fossils of man have as yet been found. Scientists say that even here careful search may uncover them.

After all, scientists have been hunting only a few years for these fossils. Wait and see what will be found, they say, when people spend large sums of money and send scientists all over the earth looking carefully for bones of early men. What they discover will be surprising.

If the scientists are correct in saying this, the newspapers may have exciting news for us any month. Let us read them every day to learn of what the scientists find.

What, Then, Do We Know about the Very Early Men?

What do the fossils prove to you? Do they prove that very many years ago men lived and went about over the earth?

In what ways were they like the men of today?

For one thing, they stood up and walked on two legs. This was different from the way that animals walked. Then, too, their skulls show that their brains were larger than those of other animals. They could think much better. Later we shall study how men began to live in different ways because they could think. The story of man has just begun.

CHAPTER XVII

The Men Who Lived in the Ice Age

ONE TIME, long, long ago, something happened to our earth. It was something very, very important. It changed the ways in which men live on the earth. What could it have been?

It was a blanket of ice that covered a large part of the earth! This big blanket was not just a thin sheet of ice like that which freezes on our ponds in winter. That ice is only a few feet thick. It covers only the lakes and ponds.

The ice covering of which we are speaking was a huge "glacier." It covered thousands of miles of land as well as of water. And it was thick — thousands of feet thick.

Figure 97 will show you what a glacier of today is. It shows how a mass of water has fallen on the earth as snow and ice.

This glacier of long ago must have been thousands of those glaciers all together. It began, per-

haps a million years ago, near the north pole and moved south on every continent and ocean. Year after year the snow must have fallen, filling in whole valleys between mountains. The air must have been very, very cold all the time. The ice and snow did not melt.

Why did it become so cold? We do not know. Some scientists think there came a long time when the sun gave out less heat. Some think the northern part of the earth tipped farther away from the sun and made that part colder. There are other reasons. But we cannot be very sure.

Deeper and deeper packed the snow. Thicker and thicker became the ice. It covered the flat lands. It filled the little valleys between hills. Then it covered the hills themselves. Thicker and thicker it became — 100 feet, 200 feet, 1000 feet.

Still the snow and hail fell, and everything froze and froze. One snowfall piled on top of another. Higher and higher the glacier became. In some places it was a mile thick and thousands of miles long. The whole country of Canada and the northern part of the United States were covered. The north of Europe was covered too.



FIG. 97. This glacier moves along the valley*, a great river of ice and snow

From Glacier

Then it began to move. Down the steep mountains it slid. Sometimes it slid quickly, at other times slowly. It crawled down the valleys.

As the huge sheet of ice moved, it picked up rocks and big stones on the way. Small stones and gravel and sand came along too. For many hundreds of miles they were carried, far away from where they had been before.

The ice sheet was very heavy, too. So heavy did it become that it crushed the crust of the earth. It scratched deep lines in the old rocks. It dug out great deep holes in the ground it passed over. It cut out new valleys in the earth.

All of this took a long, long time. Thousands and thousands of years passed while the great snows were falling and the thick ice sheet was freezing. Thousands of years passed while new places for rivers and lakes were being cut out by the sheet of ice.

During this long cold age the warm-weather plants died in the north. Many of the warm-weather animals died too. But slowly other kinds of animals grew on the earth. These animals had on thick, woolly coats. Animals like the mammoth,

The Men Who Lived in the Ice Age 227

the bear, the fox, and the reindeer had furry coats and could stand the cold air. Scientists have found skeletons of these and other animals under the layers of earth. These prove that these animals were alive during this Ice Age.

Time, long ages of time, passed. Then the climate changed again. It became warmer. Some of the glacier ice and snow melted and became water. Some of the water flowed into the great holes in the earth and made lakes. Some of it flowed off the land in new river valleys. As it moved along it made the valleys deeper than they were before.

When the ice and snow melted, the rocks and gravel which they had carried along were dropped on the way. Figure 98 shows how some of these boulders were left standing. We know that they were brought from a long way off because they are different from the stones and rocks around them. They are exactly like those hundreds of miles away in the northland.

Some of the stones were left as large boulders. Others were smashed and pounded into fine sand and dust. Some of this became a kind of soil that was good for crops.

More time passed. Thousands of years passed. Seasons of warm weather followed seasons of cold weather as they do today. Plants grew again in the warm seasons. Warm-weather animals came back again. For thousands and thousands of years seasons were much more as we know them now.

Again something happened, and the climate changed again. Another Ice Age came to the earth. The story is the same. Snow and ice piled up in the valleys. Later they covered even the mountains. When the ice and snow melted, new lakes and ponds and rivers were formed. The earth's crust was hammered and dug into and scratched. The rocks and stones were pounded into sand and soil.

Scientists think that this happened four times. Four times the great glaciers were formed; four times they melted and became water and changed the rivers and lakes.

At last, about 20,000 years ago, the climate became about as it is today. The glaciers melted off most of the northern part of our earth. The water formed the great lakes and rivers as we know them now.



FIG. 98. A giant boulder left by a glacier. Notice how small
the man seems

Ewing Galloway, N.Y.

The earth continued to spin about its axis, giving us night and day. It also moved about the sun, giving us the seasons — spring, summer, autumn, and winter.

The sun continued to give about as much heat as it does now. The plants and animals grew on the earth about as we know them today.

How Men Lived in the Ice Age

What was happening to the people who lived in the years of the Ice Age? What happened to men like the Piltdown man and the Java man? Did they live on during that very cold period?

Fossils Tell the Story

How can people today be sure that these things happened so many years ago? They cannot be perfectly sure. They can only study the fossils to learn about the long ago.

Hundreds of scientists in every continent have hunted for fossils. They have hunted on the surface of the earth as Mr. Andrews did in the Gobi in China. Others have dug deep in the ground, looking for the bones of people and the things which



FIG. 99. Men of long ago making knives, hammers, and other tools and weapons

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they used. Many have gone into caves all over the earth, hunting for the bones and tools of very early men.

What have they found? Fossils, many fossils. They have found the bones of people. In some places there were huge piles of the bones of animals near them. So we know what meat the people ate. They have found stone knives and axes, spear-heads, and other tools and weapons. And they have found drawings and paintings on the walls of the caves. These tell much about the early people and how they lived.

You have read of the Piltdown man, of the Java man, of the Peking man. These fossils are believed to be perhaps a million years old.

What, then, happened to the very early men of so long ago, during the Ice Age?

We do not know. No fossils have as yet been found that give the history of men for a long, long time after the beginning of the Ice Age. We can well believe that they could not live in the north during that cold, cold time.

The warm-weather animals could not live on the glaciers, so they either died or moved to the south.

The Men Who Lived in the Ice Age 233

No doubt the people moved as the animals did. Families and tribes of these early men would wander around for quite a while. Then, as it slowly grew colder, they would move a little south toward the warmer lands near the equator.

Then, as the climate turned warmer again and the ice melted once more, the people and the animals slowly moved to the north.

But how the people looked, what they ate, what their houses were like, what their tools and weapons were, we do not know. Perhaps a million years have passed since they lived. But no fossils have been found to tell how the men of that time lived.

The Neanderthal Man

After all that time another man appeared. In 1856 some men were going through a cave in the Neanderthal valley. There, under layers of dirt, they found the skull and some other bones of a man. Some scientists felt sure that this man must have lived perhaps 100,000 years or more ago. Because he was found in the Neanderthal valley in Germany he is called the "Neanderthal man."

Other scientists said that he was not a very

early man at all. There was a long, long argument. Thirty years later two other skulls exactly like the one in Germany were found. This was in Belgium, a hundred miles away from the Neanderthal valley. Many scientists then felt sure that the bones of an early man had been found.

A few years later more skulls and other bones were found in other parts of Europe. Later some of the same kind were found in Asia. This showed that the Neanderthal man must have lived all over Europe and in Asia.

Not only did the scientists find skulls and leg bones but also whole skeletons of men, of women, and of children.

How long ago did the Neanderthal man live? Perhaps 100,000 years ago, perhaps 150,000 years ago, perhaps even longer ago.

How can the scientists tell? Usually they can tell by the layers of earth in which the fossils are found. Sometimes the kinds of tools and weapons that are with the bones show them. Scientists know that certain kinds of tools were used by these men, because these were found with their bones.

With two of the skeletons they found that the men's tools and some plants and food had been buried with them. One young man's bones showed that he had been buried by his family very carefully. He was lying as though he were sleeping. His head was on his arm. Under his head was a small pile of flint tools. A large ax lay beside him, and near by were many ox bones that had been baked in a fire and had split open.

Such fossils tell our scientists much about early men and how they lived. They tell also about the animals that lived at the same time. When the fourth glacier was melting, there were horses and reindeer, buffaloes and cave bears, and the woolly elephants called mammoths.

From all these kinds of fossils the scientists try to tell how these early people lived. Here is a story of how one family might have lived.

A Day at the Squatting Place¹

Everybody in the Neanderthal family is busy at work. The man and the boys are out in the forest

¹ This account was made up from the statements made in such books as W. Smith's *Man, the Primeval Savage*, J. J. Atkinson's *Primal Law*, and Elliott Smith's *Human History*.

hunting for food. It is cold, very cold, and they pull the animal skins that are thrown over their shoulders closely around them. They walk quickly, looking carefully at the ground and through the trees.

The man is short and heavy and does not stand up very straight. He walks in a slow, rolling way. His neck is huge, and his body is hairy. The arms are much shorter than those of the Java man that we read about. His hands seem about like our hands today. He is very quick to learn how to lift up stones with a sharpened stick that he holds in his hand.

How quick his eyes are! The boys' eyes are quick too. As they find food here and there they make strange crying sounds. One of the boys finds some birds' eggs in nests, and they have a feast. Some of the eggs must be taken back to the women and children at the squatting place by the brook. They pick crab apples and other wild fruit off the trees. They gather berries.

The man is looking for animals with more food on them, such as rabbits and little baby bears. He is afraid to try to kill big, grown bears or lions or mammoths. He has no gun, of course — not even

an iron spear or ax. He and other Neanderthal men have not learned how to make things of iron. Their spearheads and hand axes are of stone, very rough and dull.

Suddenly, and with cries from everybody, they come upon a dead bear lying under the trees. How they all fall upon it! For although it may have been lying there for weeks, it is still food. They start at once to take it a long way back to their camp. Hours later they come slowly into the camp. What excitement there is! Young men who had been spearing fish in the little stream come rushing toward them. With their stone knives they help to cut off the skin, eating the chunks of meat as they are pulled off.

The women and children stand around waiting to be handed some of the meat. What a feast they have! How good it smells! Tomorrow the big bear-skin can be scraped clean by the women and dried in the sun. In a few days it will be ready for the baby's bed.

Then they all gather around the fire of the squatting place, shivering in their animal-skin clothes. The sun will soon go down, and it will be,

oh, so cold! The children must be wrapped up more warmly.

The man and the older boys take flints and shape them into tools. One is making a spearhead out of his piece of stone. Another has nearly finished a knife, or a scraper, with which the women can scrape the animal skins. The man is making a stone ax head. For a long time he has pounded the edge of the stone until it is thin. Now it is finished, and he puts a wooden handle to it.

At last it becomes dark. The family has no lamps or lights, only burning sticks from the fire. All of them come close to the fire, which the women and children are careful to keep burning. It is hard if they let it go out, for they have no matches to start another. If it should go out, they would have to gather very dry leaves and strike sparks from hard stones to set the leaves on fire. This is very hard for these people to do; so someone watches the fire all the time.

At last it is bedtime. All of them go to sleep close to the fire, pulling the animal skins tight about their bodies. They have no house — only a cave to live in.

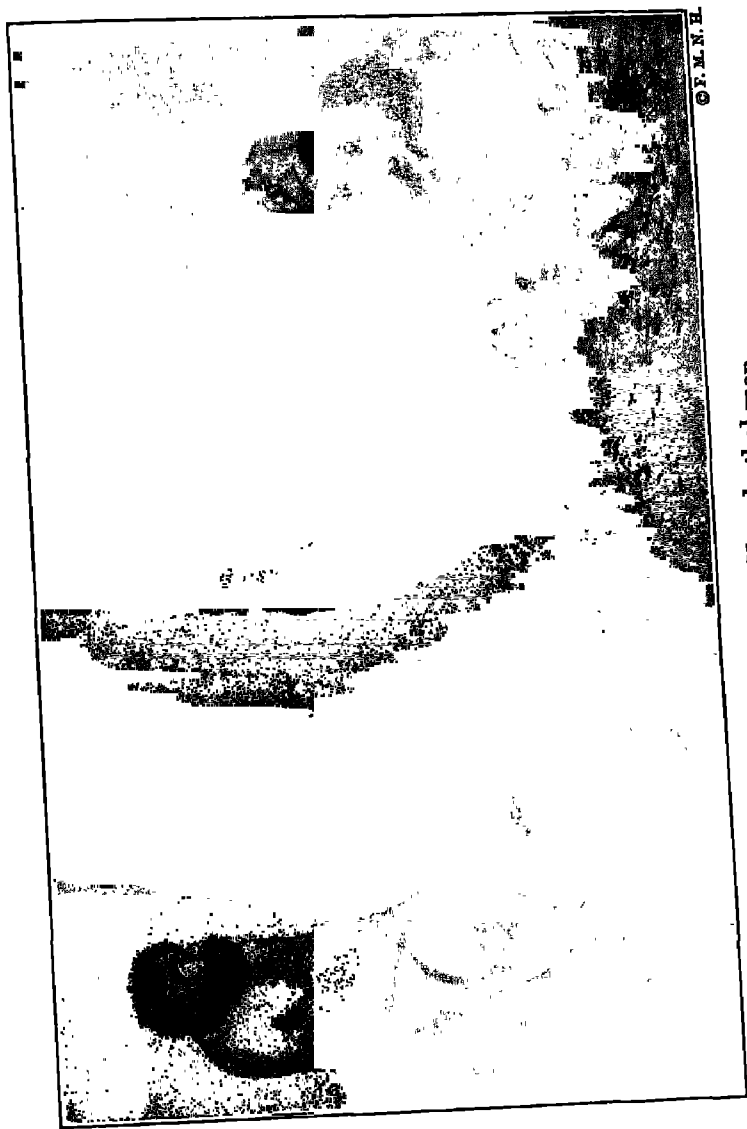


FIG. 100. The Neanderthal man

Of course we have only imagined a "day at the squatting place," but it is the way our best scientists think the Neanderthal man lived. As you read each story of how people live on the earth, remember that each one brings us a little nearer to our own times. Men were growing more and more like the men of today. You will see that this is so when you read the next stories.

CHAPTER XVIII

Finally the First True Men Came on the Earth

So, AS TIME passed, the animals went on changing and growing. The people went on changing and growing too. More and more they learned how to protect themselves from wild animals and from the weather. Slowly, very slowly, they learned better ways to live.

As thousands of years passed, men began to look different from earlier men. Their heads were larger. Their bodies were taller. Their bones were straighter, so that they could stand up very straight, as we do today. The hair grew thinner on their bodies, and finally they came to have only a little hair, and most of that was on their heads. Their hands were shaped more like ours, and their brains became larger and larger.

One reason is that the Ice Age had passed. The climate after the fourth glacier time had become as

warm as it is now. Most of the ice had melted off Europe and Asia and North America. Only a little remained, as it is now, around the north pole and around the south pole. Rocks had been pounded into fine soil by the glaciers. Warm-weather grasses and trees and plants had grown again in the soil. Warm-weather animals had grown again on the earth — animals about as we know them today.

So it was that about 25,000 years ago there were living in different parts of our earth people who were really very much like ourselves. They were so much like the people who live on the earth today that we call them the "first real men." Of course there may have been others earlier who were like them, but we cannot prove that as yet.

Where Did the First Real Men Live?

The scientists have been trying to answer this question for many, many years. They have never all thought the same about it. Some think they lived first in America. Some feel sure it was in Africa; some, however, say in Asia; others, in the islands of the Pacific. Ever since the scientists have been hunting fossils they have talked and argued

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about this. Every time a new fossil of a man is found the argument starts again.

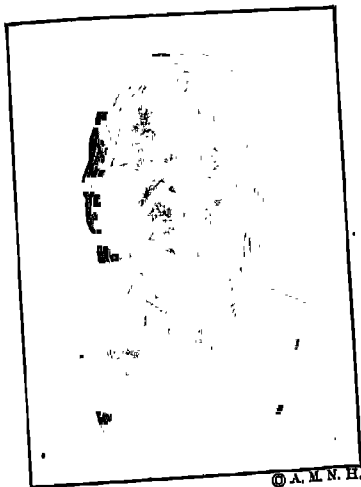


FIG. 101. Scientists think the first true man looked like this

What the scientists have learned about the earth's layers and from the bones and skeletons and tools that have been dug up in different places leads most of them to think that the first true man lived in Asia. In figure 101 the artist shows you what these scientists think. As you study this picture keep in mind that the people of 25,000 years

ago traveled in tiny groups, not in great crowds, as the picture seems to show. Two or three people at a time or families of 20 or more went wandering about through the woods or over the plains. Up and down the mountains they wandered. Sometimes they crossed the cold snow desert and at other times the hot sandy desert.

These people walked! They had no boats, no

wagons, no automobiles, no trains. So they went very slowly. Perhaps each family went only a short way in its lifetime. They lived in one place for a very long time.

In those days there was dry land in many places where deep water is now found. Even so it must have taken thousands and thousands of years for these men and their families to go from Asia into Australia, into Europe, into Africa, into North America and South America.

Different Races Settled in Different Continents

The Yellow Race

Finally different groups reached all the continents. Some stayed in Asia where China is now. Find their home on the globe of figure 102. These people belong to the yellow race.

One fourth of all the people of the earth today are of this race. The Chinese belong to the yellow race. Their skins are a yellowish white, their hair is black and very straight, and they have small eyes. We shall study about some of the yellow people in our next book, called *Nature Peoples*.



FIG. 102. Some scientists think that people lived first in Asia and went out from there to all the other continents

The Black Race

Others of the wandering people reached Africa and some islands south of Asia. They belong to the black race. Their skins are nearly black, and they have kinky black hair and black eyes. The Negroes who live in the United States come from that race. Later we shall study about people of this race too.

The White Race

Others of these wandering people finally settled in Europe. Some of them lived where Germany, Norway, and Sweden are now. Scientists sometimes call these people the Nordic race. They have whiter skins and lighter hair and eyes than people of other races. Most of the people who live today in England, Germany, the United States, and some other parts of the earth have come from this race. We shall study about them in *Communities of Men*, in *Races and Nations*, and in other books.

Other white people settled in southern Europe and in southwestern Asia. Some are called the Mediterranean race; others are called the Alpine race. Although all these people belong to the white race, their skins are darker than those of the Nordics.

Early Men

For hundreds of thousands of years people wandered over the continents. They kept on changing and changing in looks. Finally the people of the earth became more like what they are today.

As you have already learned, fossils left behind by these early men tell us much about how they lived.

Some of the Early Men Were Cave Dwellers

One thing we know very well about these first real men: many of them lived in caves. Many skeletons of people, as well as weapons and animal bones, have been found in caves. Some of these caves were very, very large indeed, a mile or more long underground, with great high rooms. Others were little caves barely large enough for a single family.

We know also that they had learned to make better stone axes, knives, spearheads, and the like than did the Neanderthal men, who lived there before them. With these they could kill bigger animals like bears, buffaloes, and horses.

We can be sure that they loved to eat horse meat, for huge piles of bones of horses have been



FIG. 103. Wild boar painted by an early cave-dwelling artist

found in different parts of Europe. In a place in France scientists found one pile of bones that came from 100,000 horses! Near by were bones of mammoths, buffaloes, and reindeer also. These had been cracked open and the soft inside taken out, showing that the meat had been eaten.

The Early Cave Dwellers Were Artists Too

Figures 103 and 104 show another interesting thing about these people of 25,000 or more years ago.



L.E.A.

FIG. 104. These cave dwellers were artists

Some of them were artists. Scientists have found paintings on the walls of the caves and have found statues and other things. These people also carved and painted on tusks and horns as well as on the bones of animals. Many such paintings and carvings have been found.

A Surprising Discovery

Only a few years ago some scientists were hunting for old caves in France and Spain. They made a surprising discovery. One of them crawled into a hole in the side of a hill and suddenly found himself in what seemed to be a large cave.

He made a light. To his great surprise he was standing beside a large underground pool of water. The rocky walls rose high all around. The man could not see the end of the pool; but he took off his clothes and plunged into the cold water and began to swim. He swam and swam. After a long time he touched rock again and climbed out of the water. He found himself on the other side of the cave, which was a mile long. Around him were many strange statues of animals, and there were carvings and paintings on the rocks also.



Drawing by Harold Sichel

FIG. 105. Life in an early village

Later other scientists went into the great cave with him. They found many paintings telling about the kinds of animals that lived long ago, such as reindeer and fishes, buffaloes, horses, cows, sheep, pigs, goats, oxen, and dogs.

Figure 104 gives an idea of how these early artists painted. We know that they had light because oil lamps have been found in the caves.

Other Early People Lived in Houses

Scientists think that some of these early men lived in huts, perhaps in whole villages of huts. In figure 105 can you see the family around the first hut? The father is coming into the camp. He is dressed in animal skins, and his spear is in his hand. He is returning from the hunt with an animal that he has killed. The mother, the baby, and another child are sitting around the fire.

Just how the first people learned to make fires we do not know. Perhaps they learned to rub two sticks together very swiftly, or to strike a piece of flint so that a spark would fly into some dry grass and cause it to burn.

Some of them used sticks to make round huts

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that looked like beehives and covered them with leaves or bark or grass. There was a little door at the bottom through which one had to crawl to get inside. Do you think this was a very large or warm or comfortable "house"?

The tents, or "wigwams," made of the skins of animals and put on poles that were stuck in the ground, were not very comfortable either. This kind of house was made by the Indians who lived long ago in our own country. Of course there were many, many other kinds of simple houses that these early people knew how to make.

Some of the Early People Became Farmers

A few thousand years later, men learned how to grow things in the ground. How they learned this we do not know. Perhaps it happened this way:

Imagine these early people eating fruit that they had picked from trees. When they had finished, they threw the seeds on the ground. During the next year they noticed that other little trees or vines grew up in that place. Or perhaps they noticed that the same kinds of plants grew up in the same places year after year as the little seeds dropped off.



Drawing by Rodney Thomson

FIG. 106. An early village built beside a lake

Slowly different people in different continents learned how to raise wheat or corn or rice or oats or other grains. They also learned how to grow sweet potatoes, pumpkins, and other kinds of vegetables. After a long, long time most of these people became settled farmers. They were no longer wanderers who lived off wild fruits and berries and the animals and fish which they could catch.

They Begin to Use Tools Too

Slowly also early men learned how to make things with tools. Some of them began to build their houses on posts near the shallow lakes. Perhaps this was



FIG. 107. This drawing shows bronze and copper axes, swords, and horns; also clay bowls

for protection from wild animals and from unfriendly men. Figure 106 shows how the houses of these lake dwellers may have looked at one time.

Scientists today have found many kinds of things that the lake dwellers used. They have found clay jars and pots buried deep in piles of shells. These things were nicely made and beautifully decorated and had been hardened over a fire. Some of them were made with knives of flint and other tools.

We know also that some of these people had learned how to make things of metal. Tools of copper and of bronze have been found. The copper was too soft to make good tools. They would not stay sharp and were not much good as axes or knives. But somehow, sometime, people found out that by mixing melted copper and melted tin they would get something very hard. This was later called bronze. We know people made bronze, because fine swords and spears and axes like those in figure 107 have been found. These, as you can see, are much sharper and better than things made of flint.

These early people learned how to make things out of other metals too. They made ornaments of lead and gold and silver to wear about their necks

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and ornaments for their arms and legs. Simple "nature" peoples who live in Africa and Asia and other continents wear ornaments today just as the nature peoples of long ago did. Our own people wear them too. They wear bracelets and rings and necklaces of gold and silver and other metals. In these they also put diamonds and many, many other kinds of beautiful stones. So we see that our people today like to "dress up" just as the cave dwellers and other early men did long, long ago.

This Must Complete Our First Book of the Earth

There are many, many other things that we could learn about these early men, but we have come to the end of this story. We have thought far back to the beginning of the suns and the stars and the planets. This was back to the time, billions of years ago, when these suns were just whirling, spinning masses of gas in the wide, wide space.

We have seen how some of these whirling gases held together as they moved through space. Our own sun and the planets that were formed out of it were held together like that. And the earth on which we live was one of these masses of gas.

Our story has told us how some of this whirling, moving mass of gas became our earth. The mass hardened and cooled, hardened and cooled, until finally it was a great round mass of hard rock.

And after millions of years passed, the blanket of atmosphere formed around it. Great rains fell upon it and winds blew upon it. As this happened the mountains were worn down. Rocks were pounded and worn down to small stones. The stones became pebbles and sand and soil.

Finally, after more hundreds of millions of years had passed, the face, or "skin," of the earth had soil and sand and gravel and stones on it. And great oceans and lakes and rivers of water had been formed.

These things changed time after time. Great earthquakes shook the earth as it whirled through space. Mountains were pushed up in new places and old ones were smashed down. Volcanoes of terribly hot lava burst through the skin of the earth and formed more new mountains. The ocean and the rivers changed too.

The weather changed many times. Sometimes great glaciers of ice covered great parts of the earth.

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Then it became warmer, and the ice melted. New rivers and lakes were formed. The changes took place many times.

And while all this was happening, plants and animals and people grew on the earth. It took millions of years for this to come about. But finally there were thousands of kinds of trees and flowers and other plants, fishes and other animals of land and sea. One kind grew out of another. They changed and changed. And finally real men appeared on the earth. These looked and lived much as do some of the simple nature peoples on the earth today. At first they found it hard to keep alive. They did not know how to make knives and other weapons to hunt and fish with and to use for fighting. They did not know how to make strong houses to live in. They did not know how to plant things in the ground and grow crops. But just the same they somehow lived. And then at last, after a million years or more, the cave dwellers and the lake dwellers and other early true men came.

Here *The First Book of the Earth* closes. But we shall continue our study with another book. It will

tell the story of some of the simplest peoples on the earth today. Because these peoples look to nature for nearly everything we shall call them "nature peoples." And that will be the name of our next book: *Nature Peoples*.

How to Pronounce Some of the Strange Words in This Book

You say *ä* as it is in *can*; *ā* as it is in *cane*; *ā* as it is in *father*
ě as it is in *bet*; *ē* as it is in *be*; *ē* as it is in *her*
ȳ as it is in *hid*; *ī* as it is in *hide*
ø as it is in *not*; *ō* as it is in *note*; *o* as it is in *horse*
oi as it is in *oil*; *ou* as it is in *out*
ōō as it is in *foot*; *ōō* as it is in *food*
ū as it is in *use*; *ȳ* like *ng* in *sing*

Aconcagua (ä kōn kă'gwä)

Africa (äf'rī ka)

Alaska (a lās'ka)

Alpine (äl'pīn)

Antarctic (änt ärk'tīk)

Antarctica (änt ärk'tī ka)

Apollo (a pōl'ō)

Appalachians (äp a läch'ī anz)

Arctic (ärk'tīk)

Asia (ä'zha)

Athos (äth'ōs)

Atlas (ät'las)

Australia (ōs träl'ya)

Balmat (bäl mǎ')

California (käl ī fōr'nī a)

Canada (kän'a da)

China (chī'na)

Chinese (chī nēz')

Colorado (köl ō rä'dō)

dinosaur (dī'nō sōr)

Egypt (ē'jīpt)

England (īŋ'gland)

Europe (ū'rup)

Everest (ēv'ēr ǽst)

Fujiyama (fōō'jē yä'mä)

Galileo (gäl ī lē'ō)

Georgia (jōr'jya)

Germany (jēr'ma nī)

| | |
|-------------------------------------|--------------------------------|
| Gobi (gō'bē) | Neanderthal (nā ān'dēr täl) |
| Grand Canyon (gränd kăn'-yun) | nebula (něb'ū la) |
| Greece (grēs) | nebulae (něb'ū lē) |
| Herschel (hēr'shel) | Neptune (něp'tūn) |
| Himalayas (hī mǎ'la yaz) | New Hampshire (nū hǎmp'-shĭr) |
| Illinois (ĭl ĭ noi') | Niagara (nī āg'a ra) |
| India (ĭn'dĭ a) | Nordic (nōr'dĭk) |
| Italy (ĭt'a ĭ) | Olympus (ō ĭm'pus) |
| Java (jǎ'va) | Peking (pē'kĭng') |
| Jupiter (jōō'pĭ tēr) | Pennsylvania (pĕn sĭl vā'nĭ a) |
| Krakatoa (krä kǎ tō'ä) | Piltown (pĭlt'doun) |
| Laplace (lä pläs') | Pluto (plōō'tō) |
| Lippershey, Hans (hānts ĭp'-ĕrs hĭ) | Pompeii (pōm pā'yē) |
| Magellan (ma jĕl'an) | Ra (rä) |
| Mars (mǎrz) | Saturn (săt'ĕrn) |
| McKinley (ma kĭn'ĭl) | Sicily (sĭs'ĭ ĭl) |
| Mediterranean (mĕd ĭ te rǎ'-nē an) | trilobite (trĭ'lō bĭt) |
| Mercury (mĕr'kū rĭ) | Uranus (ū'ra nus) |
| Mexico (mĕk'sĭ kō) | Venus (vē'nus) |
| Mont Blanc (mōn blān') | Vesuvius (vē sū'vĭ us) |

THE INDEX

How to Use the Index

This Index will help you to find things which you want to read about in *The First Book of the Earth*. It shows you which pages tell about ferns, reptiles, mountains, or other things which interest you.

Perhaps you want to read about ferns. The word *Ferns* begins with the letter *F*. Look through the Index until you come to the letter *F*. Say your A B C's. The letter *F* will be found near the beginning of the Index because it is near the beginning of the alphabet.

When you come to the letter *F* in the Index, you will see a number of words which begin with *F*. Look through these words until you come to the word *Ferns*. The letter *E* is farther along in the alphabet than the letter *A* is. So the word *Ferns* will come after the word *Farmers* in the Index.

Beside the word *Ferns* you will find the number 174. This is the number of the page in this book which tells about ferns. Look on page 174.

Perhaps you would like to read about reptiles. The word *Reptiles* begins with the letter *R*. Say your A B C's again. The word *Reptiles* will be found near the end of the Index because *R* is near the end of the alphabet. After the word *Reptiles* you will see the numbers 188 and 202. This means that you can read about reptiles on each of these pages.

Perhaps you want to read about the strange things called fossils. After the word *Fossils* you will see the numbers 167, 174, 194, 216, 221, 230. This means that you can read about fossils in six places.

After the word *Mountains* you will find the numbers 83, 99, 201. What do you think these numbers mean? Look on these pages to see if you are right.

When you are beginning to use your Index, you may need some help from your teacher. Soon you can use your Index by yourself. Then you will have a quick and easy way to find the interesting things in your book.

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